# AN ANALYSIS OF HAZARDOUS WASTE ACROSS DIFFERENT LAND USE ZONES IN MUSINA LOCAL MUNICIPALITY, LIMPOPO PROVINCE, SOUTH AFRICA

BY

HAPPY ANDANI NEMATSHAVHAWE

DISSERTATION SUBMITTED IN (PARTIAL) FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

GEOGRAPHY

IN THE

FACULTY OF SCIENCE AND AGRICULTURE

SCHOOL OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

AT THE

UNIVERSITY OF LIMPOPO

SUPERVISOR: PROF MR RAMUDZULI

CO-SUPERVISOR: PROF MJ POTGIETER

**2021**

**ABSTRACT**

Hazardous wastes (HW) refer to wastes that may or tend to cause adverse health effects on the ecosystem and human beings. These wastes pose present or potential risks to human health or living organisms, due to the fact that they are: (i) non-degradable or persistent in nature, (ii) can be biologically magnified, (iii) are highly toxic and even lethal at very low concentrations. Various types of production activities in South Africa generate many by-products, which are usually discarded but often turn out to be sources of acute environmental hazards. If not contained and handled appropriately, waste, including HW can cause significant problems. Unattended HW lying around leads to unhygienic conditions resulting in health problems. Increasing population growth, accompanied by rapid urbanization and industrialization, increases the volume of HW generated in the country. Improper waste management is aesthetically unattractive and impacts negatively on tourism by creating blight on South Africa's beautiful landscape.

The aim of the study is to assess how HW is discarded across different land use zones in the Musina Local Municipality in order to reduce and manage the negative impacts that they exert to the environment and human health. The objective was to:

(i) analyse the state and management of hazardous waste discarded by beauty salons of the central business district of Musina;

(ii) Elucidate the state and management of hazardous waste discarded by households located in the suburbs of Musina;

(iii) Document the state and management of hazardous waste discarded by automotive workshop located in the Industrial zone of Musina and

(iv) Develop tailor-made recommendations for the safe management of hazardous waste in the town of Musina, Limpopo Province, South Africa

The study was conducted in Musina Local Municipality in Limpopo province, South Africa. Musina is the northern town in the Limpopo Province of South Africa. The study sites were divided into three land use zones; central business district (CBD), suburban area, and industrial zone. In terms of methodology observations, a datasheet and a semi-structured questionnaire were used to collect data on HW management across three different land use zones. A total of 73 semi-structured questionnaires (55 in suburban area and 10 in industrial zone and 8 in the Central Business District) were

employed to document quantitative and qualitative data. Observations were used to identify the types and document quantity of HW discarded by all participants. The researcher opened the weekly municipal refuse bags that stored discarded products to list and count HW products. The information was captured on a datasheet, which recorded data on type, quantity and separation of hazardous waste from general waste.

Data was analysed via descriptive statistics. Results from Central Business District (Salons) shows that nail varnish bottles were the most discarded HW product with 250 discarded per week by all eight salons. Other HW products discarded include artificial nails, hair dye containers, plastic combs, vinyl gloves and disinfectant containers. All salons practice the same disposal method; making use of municipal refuse bags for temporary storage, which is then transported to the municipal landfill site for final disposal. None of the participants separate waste; reasons being lack of awareness of separation management. Shop owners and employees' attitude towards HW management was neutral while their level of knowledge on the environmental and human health impact was rated low. Seventy-five percent of the respondents were not aware that the products they discard are hazardous.

Results from Suburban area (household hazardous waste) shows that home cleaning products were the most discarded Household Hazardous Waste (HHW) product with 237 discarded per week by all 55 sampled households. Other HHW products discarded include personal cleaning products, miscellaneous items, automotive maintenance and gardening products. The 50 households practice the same disposal method; making use of house bin (usually pedal bins). Once the bin is full, they dispose it to the outdoors wheelie bins. The remaining five household dispose of their waste directly to the outdoor bin. None of the participants separated waste; main reasons being lack of awareness of separation management. Participants' attitude towards HW management was neutral while their level of knowledge on the environmental and human health impact was rated medium. Seventy-three percent of the respondents were aware that the products they discard are hazardous.

Results from Industrial Zone (hazardous waste) shows that plastic components were the most discarded hazardous waste (HW) product with 31 discarded per week by all 10 sampled automotive workshops. Other HW products discarded include lead-acid batteries, automotive used oil and paint containers. Automotive workshops practice

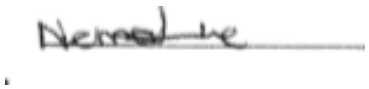
different storage and disposal method; making use of drums, large containers and old scrap car as a temporary storage place. Once the temporary storage is full, 50% opted for recycling while 30% dispose of their waste to the landfill site; the remaining 20% burn their waste in their premises. A large majority (80%) did not separate their waste; main reasons being a lack of awareness of separation management. Participants' attitude towards HW management was positive while their level of knowledge on the environmental and human health impact was rated low. Half of the respondents were aware that the products they discard are hazardous.

Many studies have looked at the comparison between wastes discarded in the rural versus urban area with little attention on specific enterprises. It is more realistic to consider other enterprises because different activities generated different waste**.** This study was able to assess how waste is discarded in different enterprises such as salons and automotive workshop with an addition of residential waste. To the best of our knowledge this is the first study of this kind. Future research can look at other enterprises such as HW from restaurant or as far as HW discarded by mining sector. The study recommends that the salon enterprise obtains a HW certificate prior to operating a salon, this will increase awareness and make employees more knowledgeable on issues relating to the management of HW. Most of the wastes discarded by sub-urban area were recyclable materials. The municipality can look into collecting recyclable materials separately and taking it to the recycling facilities. It was shocking to find out that there are automotive industries that burn their waste (without even separating). This poses a serious danger in terms of air pollution and the possibilities of containers exploding; therefore, there is an urgent need to educate people in the automotive industry.

**Keywords: Hazardous waste, Household Hazardous Waste, Musina, Central Business District**

**DECLARATION**

I declare that the dissertation hereby submitted to the University of Limpopo, for the degree of Masters of Science in Geography has not been previously submitted by me for a degree at this or any other university; that it is my work in design and in execution, and that all material contained herein has been duly acknowledged,



… ……..  07 October 2021

Mr HAPPY ANDANI NEMATSHAVHAWE  Date

## DEDICATION

This work is dedicated to my mother Avhakholwi Nematshavhawe and my grandmother Sarah Nematshavhawe who supported me throughout my studies, and to my lovely sister Maduvha Nematshavhawe

**ACKNOWLEDGEMENTS**

This study has been a long journey that would not have been successfully made if it were not for the support of various people.

First and foremost, I would love to thank God, the Almighty for His Grace and unfailing love, if it wasn't for Him, I wouldn't be where I am today.

I express my deep gratitude to Prof. MJ Potgieter for his useful critiques and constructive recommendations. I have been extremely blessed to be under his guidance and experience his unflinching support.

Special thanks to Prof. Marubini R Ramudzuli for his encouragement and advice he has provided throughout my time as his student.

Special appreciation to Dr Daniel Angwenyi for his contribution in drafting the structure of the thesis.

My grateful appreciation also extends to Dipuo Kgoete for the support and assisting with the analysing of data.

Exceptional thanks to Samson Muleya for assisting with the collection of data.

I am indebted to Mrs Rendani Kutama, manager of the Musina Local Municipality's Waste and Parks section for proving valuable insight.

A special thank you to Manamela Daphney of SD Scholar Harvest for assisting me with proofreading and formatting my dissertation

Lastly, a special thanks to the community of Musina for availing their time and sharing their knowledge

**CONTENTS**

**List of figures**

**List of tables**

## LIST OF ABBREVATIONS

| | |
|---|---|
| CBD | Central Business District |
| HW | Hazardous waste |
| HHW | Household hazardous waste |
| DDT | Dichlorodiphenyltrichloroethane |
| MSW | Municipal Solid Waste |
| CFC | Chlorofluorocarbons |
| WHO | World Health Organization |
| HWMS | Hazardous Management System |
| NEMA | National Environmental Management Act |
| NEMWA | National Environmental Waste Management Act |
| IWMP | Integrated Waste Management Plan |
| LEDET | Limpopo Economic Development and Tourism |
| NHHWF | National Household Hazardous Waste Forum |
| IDP | Integrated Development Programme |
| MMA | Methyl Methacrylate |
| IWMP | Integrated Waste Management Plan |
| LEDET | Limpopo Economic Development and tourism |
| VOC | Volatile Organic Compound |

Dissemination of information stemming from this Investigation

**Accepted Article**

Nematshavhawe, H.A., Ramudzuli, M.R. and Potgieter, M.J. 2021. The state and management of hazardous waste discarded by beauty salons of the central business district of Musina, Limpopo Province, South Africa*. International Journal of Waste Management. DOI: 10.1504/IJEWM.2022.10034892.*

# CHAPTER 1

# RESEARCH BACKGROUND

## 1.1 INTRODUCTION

Hazardous waste (HW) is defined as any waste that possesses hazard properties (such as toxicity, flammability, carcinogenicity, reactivity, corrosively), that make it a substantial present or potential hazard to humans and the environment; thus, requires strict control in the course of handling, transportation, processing and disposal. Hazardous waste management systems (HWMS) entail collection of HWs, their transportation to facilities with proper processing technologies or final disposal. (Yilmaz *et al.,* 2017). Disposal and management of waste are world-wide problems. Poor outdated and illegal practices of urban and hazardous waste disposal affect local communities virtually in all countries; this includes illegal transboundary trade, mostly from industrialized countries (Marsili, 2009). Hazardous waste generation results from economic development, and should be managed by recycling, incineration, landfill, or reuse (Cao *et al*., 2018).

Household hazardous waste (HHW) arises from household products that have not been consumed or used in the household and are potentially harmful to the people who live in a residence, and to their neighbours if it is they are not disposed of properly (Lim-Wavde *et al*., 2019). Examples of HHW include cleaning products, automotive products (car batteries, motor oil, and antifreeze), lawn and garden products; paints, electronic wastes (computers, televisions) and kerosene (EPA, 2014). Often these wastes are disposed improperly; for example, by pouring it down a household drain, onto the ground, into storm sewers, or simply disposing them together with the regular trash. If this happens, waste materials can contaminate the land and infiltrate the ground water, and consequently create adverse effects on the environment and people's health (U.S. EPA, 2015).

Industrial hazardous waste is a special kind of waste, which could be toxic, flammable, explosive and corrosive; chemically reactive, infectious and radioactive. It does not only pose risks to the surrounding air, water and soil, but also do harm to the ecological environment and human health through diversified channels (Li *et al*., 2015). Since the industrial and technical revolution, the increasing amount of industrial HW had brought extreme pressure to the environment (Samanlioglu, 2013). The main sources of

industrial HWs are mining, chemical, mechanical, pulp and paper industries; cement production facilities, wood remanufacturing facilities, etc. Important industrial HWs include used oil, oil contaminated materials and spent solvent (Thanh *et al.,* 2010). Nevertheless, there is limited data on the quantities of industrial HW, where is going, where it is generated and disposed of. However, due to the accelerated development of economies, mass manufacturing and processing industries; less strict standards and regulations on environmental quality assessment; the quantities of industrial HW will continue to increase (Mmereki *et al*., 2016).

Cosmetic is defined as any product designed to improve one's appearance, the products contribute largely to pollution through improper disposal (March, 2018). Chemicals found in these products are linked to diseases such as cancer (UKssays 2018). Although these products are safe enough for everyday use in the salons, they require special disposal (Ellis, 2019). Ultimately, salon and spa professionals should strive to minimize or completely remove the generation of HW by eliminating as many of its waste stream as possible (Scheel, 2019). By managing HW in a safe compliant way you will ensure the wellbeing of humans and the safety of the environment.

### 1.2 PROBLEM STATEMENT

Human activity generates waste. This is not a major issue when the population is relatively small and nomadic, but it becomes a serious problem with urbanization and the growth of large conurbation (Katheem *et al*., 2015). If not contained and handled appropriately, waste, including HW, can balloon into a significant problem. Hazardous waste is waste that has substantial and/or potential threats to public health and environment (UNEP, 2006). Unattended HW lying around leads to unhygienic conditions resulting in health problems (Alamur and Kara, 2007). Chemicals like cyanides, mercury, and polychlorinated biphenyls are highly toxic and can lead to various ailments such as skin afflictions. Hazardous waste furthermore affects the environment by debilitating plants and animals, interrupting their growth cycles and even leading to extinction (Espinoza, 2018). Improper waste management is aesthetically unattractive and impacts negatively on tourism by creating blight on South Africa's beautiful landscape (Crabtree, 2016). Hazardous waste generation rates in rural communities are less than that in urban areas and the type and quantity varies across different land use zones. This study therefore seeks to assess how HW

is generated and managed in the Musina Local Municipality in order to reduce and manage the negative impacts that they exert on the environment and human health.

## 1.3 STUDY RATIONALE

Economic development, a growing population and increasing rates of urbanization in South Africa resulted in increased HW generation, which requires establishing and implementing effective waste management policies and program (StatsSA, 2011). The management of HWs remains a central environmental issue internationally. In developing countries, many of which are in sub-Saharan Africa, there is little information concerning the management of HW (Joshua *et al*., 2014). A case study conducted in South Africa shows that, there are approximately 540 landfill sites, but only 5% of waste is disposed of in designated sites, thus most waste in South Africa is disposed in environmentally dangerous sites (Ogola *et al*., 2011).

Hazardous waste is regarded as the most toxic parts of the waste stream (Nnedinma, 2010). Households and municipalities are supposed to take the seriousness of handling and managing HHW. A case study of the analysis of the management of HHW in Enugu Metropolis in Nigeria found that a major problem is that 44.3% of the households face the lack knowledge of HHW management (Nnedinma, 2010). Most people do not even know that they are hazardous and need to be handled with care and not disposed of with other HHW.

Six types of HW generated in Africa have been identified as being of major health concern are; Health care and medical waste; used oil, used tires, used automotive and dry cell batteries; stock of obsolete pesticides and Polychlorinated pesticides. Over 42 million cubic metres of general waste is generated every year in South Africa with Gauteng province contributing 42%. In addition, more than 5 million cubic meters of HW is produced yearly, mostly in Mpumalanga and KwaZulu-Natal. This is a result of the concentration of mining activities and fertilizer production in these two provinces. The average amount of waste generated per person pay day in South Africa is 0.7 kg (Department of Water Affairs, 2016).

In Musina, settlements face the challenge of managing hazardous products as many of these are flammable and contain toxic ingredients and therefore cannot be disposed of in drains, sewers or on the environment. Currently, there is no study related to waste management in Musina. It is therefore empirical to conduct a study that can assist in

assessing the state of HW generation and management in South African communities (EPA, 2014).

### 1.3.1 Aim

The study aims is to analyze the state and management of hazardous waste generation across different urban land use zones (retail/service (CBD salon), residential (household), industrial (automotive sector) in the Musina Local Municipality, Limpopo Province, South Africa.

### 1.3.2 Objectives

The objectives of the study are to:

i. Analyse the state and management of hazardous waste discarded by beauty salons of the central business district of Musina, Limpopo Province South Africa.

ii. Analyse the state and management of hazardous waste discarded by households located in the suburbs of Musina, Limpopo Province South Africa.

iii. Analyse the state and management of hazardous waste discarded by automotive workshop located in the Industrial zone of Musina, Limpopo Province, South Africa.

iv. Develop tailor-made recommendations for the safe management of hazardous waste in the town of Musina, Limpopo Province, South Africa

### 1.3.3 Research questions

i. What is the current state and management of hazardous waste discarded by beauty salons of the central business district of Musina, Limpopo Province South Africa?

ii. What is the current state and management of hazardous waste discarded by households located in the suburbs of Musina, Limpopo Province South Africa?

iii. What is the current state and management of hazardous waste discarded by automotive workshop located in the Industrial zone of Musina, Limpopo Province, South Africa?

## 1.4. OUTCOMES OF THE STUDY

Hazardous waste management is already a challenge nationally thus the results will be of value to the Musina Local Municipality since the study will devise an adaptive management plan.

## 1.5 SCOPE AND LIMITATION OF THE STUDY

The study had limitations that defined its scope. The total number of salons in the CBD (n=8) and automotive workshop (n=11) were relatively low and this makes it difficult to predict the trend hence no statistical analysis was used. The research could have been more effective if statistical analysis was conducted in order to compare how the three zone differs from each other. The study is pre-covid study therefore, findings of the study was not impacted by COVID-19 Pandemic.

## 1.7 THEORETICAL FRAMEWORK

The study will employ two theories. For HW discarded by salons and automotive workshop a micro level model theory will be applicable. The theory indicates that an industry generates waste as by-products of its production process. It further explains that when price of waste disposal in the legal market is raised the legal amount of disposal is at its lowest level. This also leads to waste generators to increase their demand for illegal disposal. For household the theory of reasoned action ‘wil be applicable. In environment behavior term, this theory shows that the perceived education about environmental issue leads to an action, which is called automatic environmental behaviors. (Kollmuss & Agyeman, 2002).

## Summary

Chapter 1 serves as orientation of the study it provides a brief introduction and problem statement. It explains the scope of the study, the limitations and research questions. Furthermore, it elucidates the aim, objectives, and the theoretical framework of the study.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 INTRODUCTION

This chapter presents reviewed literature with regard to hazardous waste (HW) and its management. It specifically focuses on discarded HW. Issues that are covered include aspects such as the definition of waste and its compounds, waste identification methods, waste disposal, environmental and human health impact and management strategies of HW amongst others.

Waste has been the main environmental problem in the world ever since the industrial revolution. Different scholars and organizations define the concept waste in different ways. The UNSD (2006), defines waste as materials that are not prime products for which the generator has no further use in terms of his or her own purpose of production or consumption and wants to dispose of. If waste is not properly dealt with, it poses a threat to public health and the environment. Waste is a growing issue linked directly to the way societies produce and consume goods. Meanwhile, people are generating waste and it is only appropriate to manage it at the same time.

Waste management is one of the essential utility services underpinning society in the 21st century, particularly in urban areas. The management of HWs is of great importance due to their environmental health, social, and economic impacts. Gradually the world experienced a dramatic increase in the amount of HW generated (Couto *et al*., 2013). In developing countries, the management of HW is exacerbated by lack of comprehensive legislation, unauthorized dumping and separation of various wastes at source.

Unfortunately, the consequences of doing little or even nothing to address waste management can be very costly to societies and to the overall economy. In the absence of waste regulations and their difficult implementation and enforcement, a generator of waste will tend to opt for the cheapest available course of action of disposal (ECDW, 1991). For example, household solid waste may be dumped on the street, on vacant land, or into drains, streams or other watercourses, or it may be burned to lessen the nuisance of accumulated piles of waste.

## 2.2 IDENTIFICATION OF HAZARDOUS WASTE

Adapted from the master Recycling Plan (2019) the following are ways to identify HW products. Product labels can provide clues to the hazard of the product. They may not say "hazardous," but other words mean the same thing: "flammable," "corrosive," "reactive," "explosive," "toxic," "poisonous," "volatile," "combustible" or "caustic." All of these products should be handled with care, and attention given to the directions on the label for safe use. If the product is toxic to humans, it will carry one of the words, "DANGER," "WARNING" or "CAUTION." The chemical industry evaluates toxicity by determining what the lethal dose is for 50% of laboratory test animals (LD50) exposed to the product. One can learn the LD50 of any pesticide chemical by calling the National Pesticide Telecommunications Network at 1-800 -858-7378. Products with the warning label "DANGER" are highly toxic. Most poisons fit into this category. Such products require substantial precautions in their use, and disposal of excess may be difficult. The word "WARNING" indicates moderate toxicity. Caustic cleaners are moderately toxic and have "WARNING" printed on their labels. The word "CAUTION" generally means low toxicity. Household bleach is relatively low in toxicity and therefore has "CAUTION" on the label. Bleach for example is still toxic; it just takes more of it to cause a health problem. These warnings pertain only to acute toxicity, not to long-term effects. Absence of a warning label does not mean a product is safe nor are all producers required to list ingredients.

## 2.3 HAZARDOUS WASTE MANAGEMENT

Currently, HW is one of the main global ecological hazards and the primary cause of environmental disasters (Trivedi *et al*., 2015). This type of HW has dangerous properties and exerts harmful effect on human health and the environment. Management of HW is one of the major environmental issues because it requires accurate information on the amounts of different types of HW. The Lack of sufficient information on HW results in failure of their control and monitoring (Öncel *et al.*, 2017).

The management of HWs has become a specialized discipline because of the complex nature of the problem and the solutions available to humanity. HW management, therefore, deals with minimizing harmful effects on humans and environment by applying special techniques of handling, storage, transportation, treatment, and disposal of HWs (Saleh, 2016). Disposal and management of waste is a global

problem. Outdated and illegal practices of hazardous waste disposal affect local communities virtually in all countries (Fazzo *et al*., 2017). Landfilling is not accepted as an efficient way of treating HWs in most developed countries due to various health and environmental risks associated with it.

However, in most developing countries, HHWs end up in landfill sites as mixed waste with other domestic and medical wastes. This practice has been reported to have several environmental consequences including contamination of groundwater resource, injury of waste workers, and risks to local waste collectors who collect some discarded materials for recycling (Bernstein, 2004). Landfilling of hazardous wastes has been reported to be unsuitable due to the complexity and nature of the wastes. Fauziah and Agamuthu reported a mixture of HWs and non-hazardous wastes in a municipal landfill in Malaysia, of which about 1.5% of household wastes were classified as hazardous waste. Such a system of disposal is very dangerous to scavengers of valuable and recyclable wastes as they are faced with all forms of risk going through a pile of solid wastes. Cases of HWs in landfills of developed countries have been reported despite several measures that have been instituted.

## 2.4 COMMERCIAL HAZARDOUS WASTE

Commercial waste is any waste produced by a business on its premises. The study focused on waste discarded by salon located at the CBD of Musina. The barbing salons proliferates most urban centres, discarding different waste stream (Mshelia, 2015). There are many environmental and health risks associated with the cosmetology and beauty industry in the big cities due to chemicals found in products (Bigambo, 2017). Comprehensive research on packaging of the beauty industry waste management is needed starting from the prevention stage, process efficiency, utilization of waste into products and processing of waste to meet quality standards so that it can be discharged into the environment (Purwanto and Permana-Citra, 2019).

## 2.5 HOUSEHOLD HAZARDOUS WASTE MANAGEMENT

Household hazardous waste (HHW) arises from household products that have not been consumed or used in the household. These types of waste include several household products like cleaning products, paints, garden and lawn pesticides; automotive products, electronic wastes, wood that is treated with dangerous substances, pharmaceuticals and photographic chemicals disposed of

Chlorofluorocarbons (CFC) containing equipment (Slacka *et al*., 2005). These waste products are potentially harmful to household members and to their neighbours if they are not disposed of properly (U.S. EPA, 2014).

If not well-managed, unpredictable negative outcomes of HHW can occur at its source (residential households), waste collection points, during transportation, and after deposit in landfills and/or incineration sites, with the potential to cause permanent damage to the environment and public health (Gu *et al*., 2014). According to Edokpayi *et al*. (2017), HHWs discarded in the trash may burn or explode in the collection truck. Trash collectors may be injured from smokes and splashing chemicals. In landfills, leakage from the waste pollutes soil, surface water, and groundwater aquifers. Disposal of HHWs in drains might also pollute drinking water, while in septic systems; HWs can kill the organisms that make the system work. This may cause bulk of untreated wastes to drain into the soil and eventually seep into the groundwater. Good practices of management, handling, and disposal of these wastes should ideally begin in the household (Inglezaki and Moustakas, 2014).

A study by Marwa (2000) in Tanzania, revealed that the country faces severe consequences resulting from HHWs mismanagement. Furthermore, the problems are worsened by low public awareness about where wastes are generated, or about their nature and effects. This low awareness even extends to well-educated people. Safety and health issues resulting from the mismanagement of HHW are complicated by ignorance, legislative deficiencies, enforcement laxity, technological deficiencies and poverty. Besides the convenience and effectiveness of HHW collection programs, household knowledge and awareness is an essential aspect that can encourage household participation in waste management (Lim-Wavde *et al.*, 2016).

## 2.6 INDUSTRIAL HAZARDOUS WASTE

Globalization, rapid population growth and industrial development have led to huge quantity of industrial waste during last few decades (Rai and Rao, 2005). About 6.2 million tons of total HW is generated annually in which 10 to 15 percent is assumed as industrial hazardous waste and it will increase every year with the rate of 2 to 5 percent (Naveen, 2018) Although this study focused only on hazardous waste from the automotive workshop there are still variety of sector where Industrial hazardous

waste can be discarded. This includes various types of factories, mining, textile mills, food manufacturing, consumer goods, industrial chemicals, printing and publishing.

Automobile waste management is threatening being one of the most difficult environmental issues of this century. (Nwachukwu *et al*., 2010). Automobile wastes are sometimes regarded as bulky waste, which include waste generated from servicing vehicles, automobiles, motorized trucks, and related equipment. These wastes comprise of battery, scrap metal, used motor oils and lubricants; hydraulic fluids, bottom sludge, old motor parts, greases, waste engine oil, paints, petrol and diesel, which are generated and disposed indiscriminately (Kanayochukwu Nduka *et al*., 2020).

Common plastic components in automobiles include bumpers, fuel tanks and instrument panels. Research has been undertaken among several organizations to identify alternative treatments for these large plastic portions, which are currently a major constituent of shredder residue in landfill (Paul *et al*., 2007). Recycling of these materials helps address environmental concerns and allows them to address the issue of resource depletion (Sharma *et al*., 2016).

## 2.7 ATTITUDE KNOWLEDGE AND AWARENESS

Community participation has a direct bearing on efficient solid waste management. Yet, the municipal authorities have failed to mobilize the community and educate citizens on proper waste handling and storing practices in household, shop and establishment level (Asnani, 2006).

Today, lack of awareness of urban dwellers to waste generation and disposal has caused great damage to the human ecosystem. Poor awareness of urban dwellers to waste generation and disposal has impacted negatively on the human health and sanity. For example, Afangideh *et al.* (2012) found that residents in Calabar Municipality (Malaysia) were not conscious of the implication of poor waste management, which has resulted to the poor nature of the environment in the area.

Furthermore, Phil-Eze (2014) found that level of householders' awareness on the danger of household hazardous waste is low in Nigeria. This low awareness may largely be attitudinal as income level and/or level of education played little role in the general level of awareness amongst various socio-economic groups. However, since environmental enlightenment changes the community's attitude to waste management

and disposal, it is therefore the responsibility of the various agencies in the industry to ensure effective waste management and disposal in order to avoid heath implications in the area.

## 2.8. ENVIRONMENTAL IMPACTS OF HAZARDOUS WASTE

Hazardous waste has enormous impacts on the environment. Air, soil, water and wildlife health are all affected by the amounts of HW generated and discard everyday by businesses and Industry. Regulations exist to help us dispose of it properly, but contamination still occurs always (Espinoza, 2018). Cosmetics contain a host of chemicals that may damage the environment. A simple stroll down of cosmetic or shampoo aisle will reveal just how dangerous these chemicals are (Folk, 2018).

Mishra *et al*. (2020) found that P-phenylenediamine (which is found mostly in in cosmetics product) are more toxic metabolites, which then significantly reduced plant growth, thereby having a direct bearing on ecosystem service. Palm oil for example, which is used in approximately *half* of all consumer goods, is causing widespread deforestation plus the extinction of many animal species. To avoid adding to the problem, the best way to identify if a product's ingredients have been sustainably sourced is to look out for the Fair Trade and Rainforest Alliance logos on the packaging (March 2018).

## 2.9 HEALTH IMPACT OF HAZARDOUS WASTE

In Africa, The World Health Organization (WHO) estimated that 1/3 of the burden of disease is attributed to environmental risk factor (Corvalan, 2006), HW being the main factor (McCormack, 2016). Hazardous Waste management is of particular concern (Nweke 2010). In most African cities less than 20% of urban waste is disposed of in landfills site. The remaining waste ends being illegally dumped (Achakeng, 2017). According to Sempebwa (2010), many communities in developing countries live near dumping sites; because of insufficient waste management processes such communities are susceptible to diseases and toxic effects. Hazardous wastes usually contain toxic chemical substances such as mercury, lead, sulphur, arsenic, and cyanide, which are dangerous to human health (Akpan and Olukanni, 2020). Exposures to lead can lead to an increase in blood pressure, sleep disorders, kidney damage, and nerve disorders amongst others (Eneh and Agunwamba, 2011). Similarly, Mercury is known to be a neurotoxin in several forms, which could lead to

mental deficits in low exposure levels and severe neurologic effects at extreme levels of exposure (Nweke and Sanders III, 2009). Other manifestations range from burning eye sensations, leg swelling, liver fibrosis, and chronic lung disease to skin cancer (Choong *et al*., 2007). Water contaminated by substances such as Dichlorodiphenyltrichloroethane (DDT) can cause hormonal and generative difficulties; impairment to the neuronal system, liver and nephron damage and tumour to list a few. Household waste comprises of substances that can give rise to severe and enduring risks to human health and to the wellbeing of people managing them; thus requires a high level of monitoring and management as humans interact with them every day.

## 2.10 STRATEGIES TO IMPROVE HAZARDOUS WASTE MANAGEMENT

### 2.10.1 Reduction

The approach of reducing waste can be achieved by purchasing only the products that are needed. To reduce and manage waste, one need to purchase products of good quality that will last longer, for instance people can buy long lasting products such as reusable cups, water bottles and silverware. Cautious selection of materials used can decrease the volume of wastes generated. For better management of waste, reduction of waste must be considered before reusing and recycling (DEAT, 2000). Source segregation is the easiest and most economical method of reducing the volume of HW. Through a desire to reduce manufacturing costs by using more efficient methods, industry has implemented various process modifications. Although a manufacturing process often may be used in several plants, each facility has slightly different operating conditions and designs. Thus, a modification resulting in HW reduction may not be applicable industry wise. Also, proprietary concerns inhibit information transfer.

### 2.10.2 Reuse

What is waste to one may be regarded as raw material to another as some by-products can be reused. Using a product again for the same purpose as the original one is referred to as re-use. Materials such as plastics and containers can be washed and used again in order to minimize the generation of waste Source.

### 2.10.3 Recycling

Recycling is the process of making a new or different product out of the product that is no longer of value. Recovery means recycling, composting and taking waste to

energy facilities (Ottman, 2000). Recycling reduces the use of raw materials, whereas recovery of waste helps in reducing waste (for example, metals, as well as oil minimize the impacts on the environment). Separation and cleaning of waste should be done in order to make the recycling process easier (DEAT, 2000).

## 2.11 APPLICABLE LEGISLATIONS RELEVANT TO THE MANAGEMENT OF HAZARDOUS WASTE

### 2.11.1 The National Environmental Management Act (Act 107 of 1998) [NEMA]

The National Environmental Management Act, Act 107 of 1998 (NEMA) as amended is the framework Act dealing with environmental management in South Africa. It imposes a duty of care on every person who causes environmental degradation to put measures in place to stop, reduce or rectify the pollution as it occurs. The environmental impact assessments that are required for the establishment and management of waste facilities are conducted under this legislation. The national environmental management principles in Section 2 of the Act provides a sound management of the environment, which include waste aspects such as the polluter pays, duty of care, proximity, regionalization and cradle-to-grave principles.

### 2.11.2 National Environmental Management: Waste Act, 2008 (Act N0. 59 of 2008) [NEMWA]

The National Environmental Management Act: Waste Act, Act 59 of 2008 (NEMWA) as amended regulates waste management in order to protect people's health and the environment by providing reasonable measures. These measures are for: prevention of pollution and ecological degradation; securing ecologically sustainable development; providing institutional arrangements and planning matters; providing national norms and standards for regulating the management of waste by all spheres of government. Furthermore, to provide for specific waste management measures, to provide for the licensing and control of waste activities, to provide for the remediation of contaminated land, to provide for the national waste information system, to provide for compliance and enforcement; and to provide for matters connected therewith.

### 2.11.3. The Hazardous Substances Act (Act 15 of 1973)

The Hazardous Substances Act, Act 15 of 1973 controls the disposal and dumping of scheduled hazardous substances. This schedule of products has relevance to any waste manager.

### 2.11.4. Health Act, 1977 (Act NO. 63 of 1977)

The National Health Act, Act 61 of 2003 controls nuisance (which can be caused by waste) and compels local government to take steps to prevent the occurrence of unhygienic conditions. The implementation of this Act is of importance for local government.

## 2.12 MUSINA WASTE SITUATION ASSESSMENT

According to the 2017 Integrated Waste Management Plan (IWMP) developed for Musina Local Municipality, waste management in the area will be highly influenced by the rate of urbanisation, population growth and immigration from the neighbouring countries such as Zimbabwe. While population growth is not expected to increase materially over the next 5 years, it is still important that the local municipality plans for waste management in advance. The main change to the profile of waste collection in area will be the development and expansion of the urban centres as a result of the rural to urban migration and the development of these areas.

This could manifest itself in the following manner:

- Influx of undocumented foreign Nationals;

- Mining and Tourism;

- Plans to transform Musina Municipality into a city;

- Informal settlements (if the migration is not managed);

- Increased service-based industry to support the demands of the influx of people and the development of the region in general.

### 2.12.1 Categories of waste generated in Musina

Waste generated in the Musina Local Municipality can generally be categorised as follows:

General domestic and commercial waste: this consists of paper, plastic, metal, glass, putrescible, food waste, garden refuse, textile, E-Waste, cardboard, diapers and building rubble etc.

Industrial waste: this waste is derived from industrial activities taking place in Musina, such as waste from Tiger Brands, Military Base (tomato pomace, which is used for game feeding, plastic, paper, cardboard etc.).

Medical waste: this includes hazardous medical waste such as sharps and infectious waste.

Hazardous waste: includes waste such as sewage sludge and oil from workshops.

### 2.12.2 Recycling in Musina

The South African Government has implemented numerous pieces of waste legislation over the past five years with the aim of reducing the impacts of waste on society and the environment, and on increasing the diversion of waste away from landfilling towards reuse, recycling and recovery. In 2018 the Musina Local Municipality had five recycling companies that are privately owned. The recycling companies recycle recyclables such as papers, bottles, cardboard and plastic. Recycling companies get most of their recyclables from the shopping complex, schools, and municipal offices. Recycling companies sent most of their recyclables to Gauteng province to companies such as Sappi Refibre, Mpact etc. The Municipality currently does not have waste infrastructures such as buy-back centres and transfer stations, however, the municipality provides some level of support to the local recycling companies and these include:

- Access to information on waste recycling.

- Referral to attend waste management seminars hosted by Limpopo Economic Development and Tourism (LEDET).

### 2.12.3 Illegal dumping in Musina

Illegal dumping is prominent in Nancefield and the CBD. Marginal illegal dumping can be seen in Bergview, and towards the South African Military Base. This trend is likely the result of the fact that these areas are the places with the highest density of people per square meter. Prominent waste at the illegal dump sites includes domestic and garden waste. The increasing number of people in each household in turn lead to increased amount of waste generated per household. There are various illegal dumps signages in some spots, but these are being ignored.

### Summary

Chapter two gave the outline of the literature review on the identification of hazardous waste. It further explained the different type of HW generated in different zones mainly commercial, household, and industrial HW. Attitude, knowledge, and awareness were also outlined. The practical and legislative considerations were mentioned in this chapter. The study further explained the different impacts that HW can cause to the environment and human health.

# CHAPTER 3

# METHODOLOGY AND ANALYTICAL PROCEDURES

## 3.1 STUDY AREA

The municipality of Musina is home to an estimated population of 42 964 people, living in sum of 8421 households. Musina and surrounding areas under the Musina municipality is the gateway to South Africa from Zimbabwe. It has the potential to grow in socio-economic aspects. Tourism is a big income drawer to the region. It is envisaged that further development in this area will occur. The municipality, however, has enormous challenges in meeting the economic, infrastructural and social needs of its citizens. Service provision in terms of waste management is not up to standard. Only 57 percent of the population lives in urban areas and as such assumed to have access to waste removal provided by the municipality. Local authorities are legally obliged to provide waste management services to communities residing within the municipal boundaries.

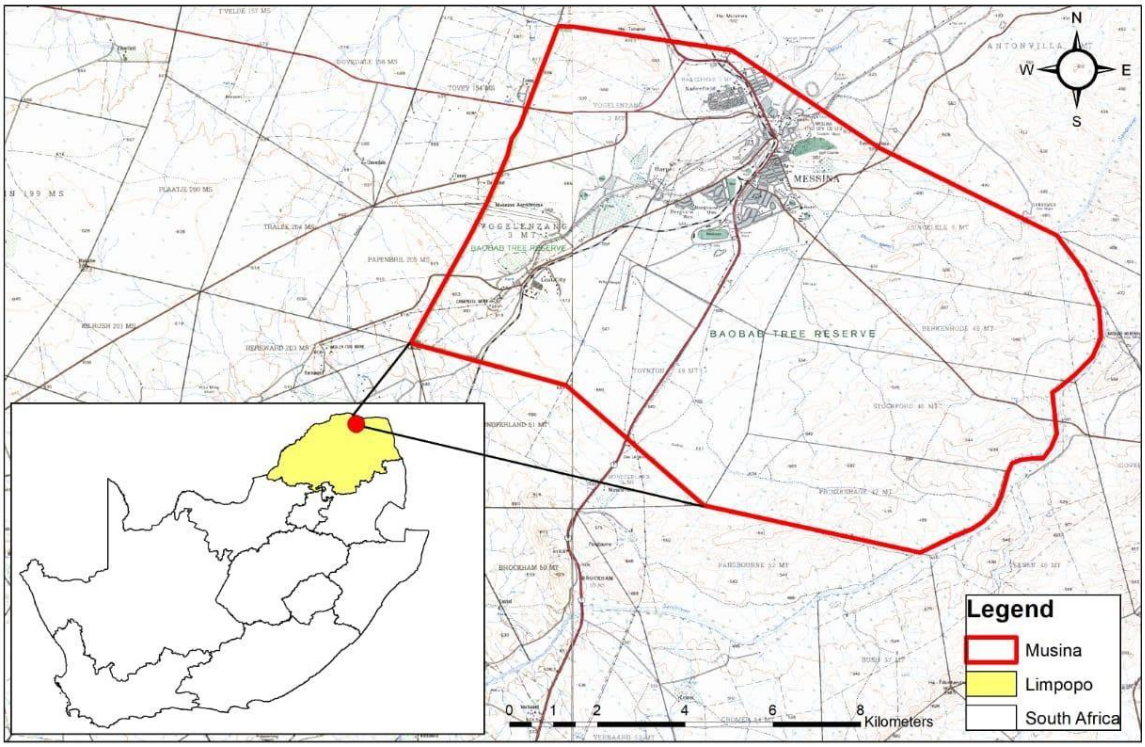



Figure 3.1 Musina location in the Map of South Africa

## 3.2 STUDY SITE

The Central Business District (CBD) (Figure 3.1 A) of the town of Musina in the Limpopo Province (South Africa) consists of a mix of offices, financial, retail, department stores and other businesses, which includes a number of supermarkets and restaurants (LED Strategy, 2007). After a pilot survey it was decided to target beauty salons, seeing that this enterprise use and generate various hazardous products.

Three residential areas (Extensions 4, 7 [Bergview], and 8 – Figure 3.1 B) were selected for inquiry into household hazardous waste management. These three areas consist of different socio-economic demographic groups, covering middle and high socio-economic income groups.

Musina is one of the areas that has been declared a growth point by the Provincial government. The establishment of the Special Economic Zone is a true reflection of the fact that the Municipality is growing very fast (Musina Local Municipality, 2018). The industrial zone (Figure 3.1 C) consists of a diverse range of manufacturing businesses, which include amongst other, heavy steel industries, automotive shops, energy and Metallurgical factories, as well as various types of timber businesses (IDP Office, 2012/13-2017).

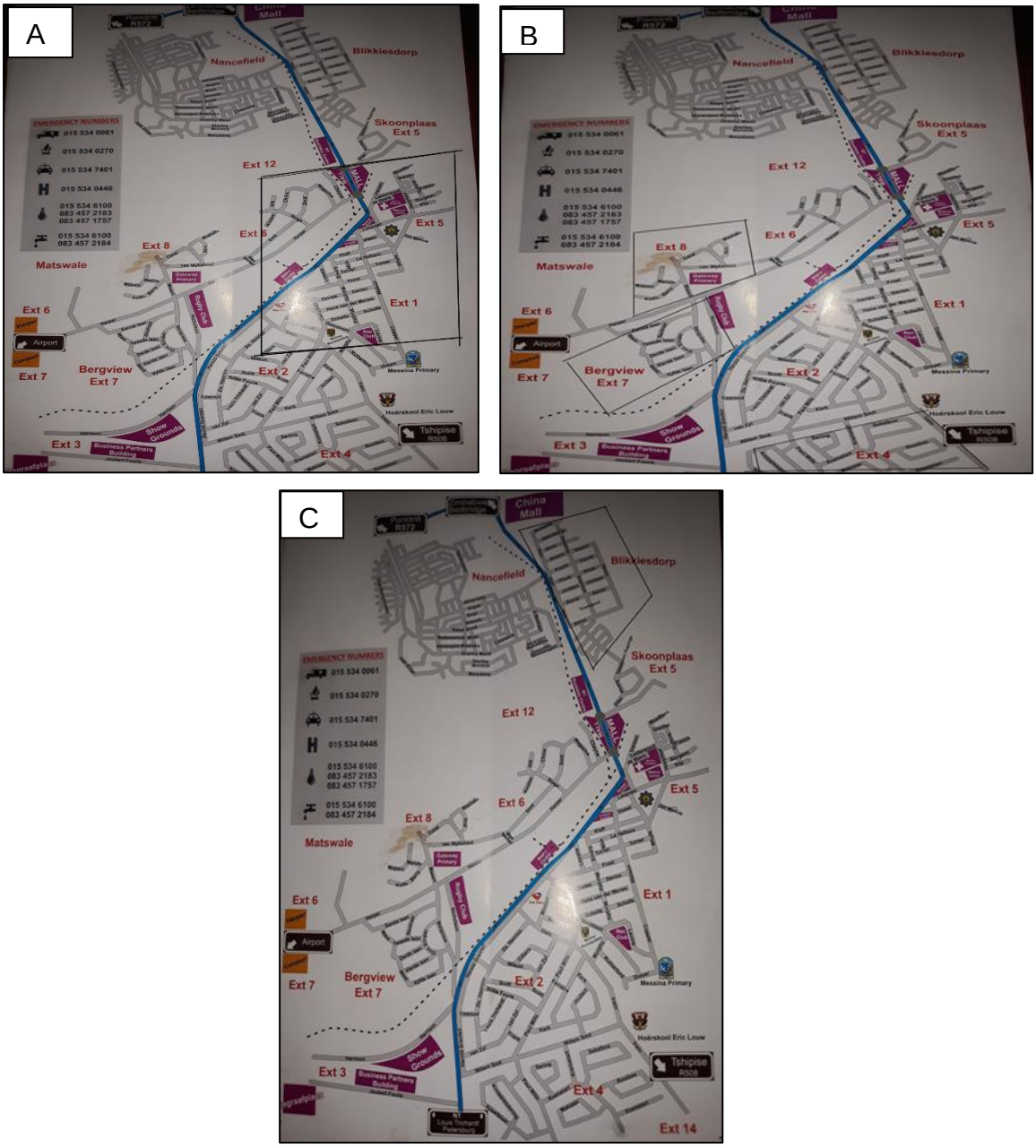



Figure 3.2 Location of study areas (bordered). A. Central Business District B. Residential areas C. Industrial zone.

### 3.3 STUDY PARTICIPANTS

For the CBD study, data was collected during January 2020 using face-to-face meetings with owners (n = 5) of beauty salons operating in the CBD of Musina. When owners were not available, managers (n = 1) of these enterprises were introduced to the project and enlisted for the study. When the above two participant groups were not

available, then employees (n = 2) were interviewed. All 8 salons in the CBD were selected for the study.

Information was collected during May 2020 using face-to-face meetings with head of the house (n = 25). When the household head was not available the Matriarch of the house (n = 23) were introduced to the project and enlisted. When the above two participant groups were not available, then housemaid (n = 7) was interviewed. A total 55 household formed part of the study.

Data was gathered during June 2020 using face-to-face meetings with owners (n = 4) of automotive workshops operating in the industrial zone of Musina. When owners were not available managers (n = 6) of these enterprises were introduced to the project and enlisted for the study. When the above two participant groups were not available, then employees (n = 2) were interviewed. All ten automotive workshops operating in the CBD were selected for this study.

### 3.4 METHODOLOGY

Central Business District

Observations, a datasheet and a semi-structured questionnaire were used to collect data on HW management on the beauty salon industry in the CBD. A semi-structured questionnaire was used to collect qualitative information, while a datasheet was employed to document quantitative data. The questionnaire gathered information on the demographic profile of the respondents such gender, age group and level of education as these parameters have a direct impact on waste management, according Panyako *et al*. (2015). The questionnaire also requested information on HW management, attitude towards HW, and awareness of the impact of HW on the environment and human health. Convenience sampling was used for this study. This method was deemed appropriate for this study due to time limitations.

Observations were used to identify the types, and document quantity of HW discarded by all eight salons. The researcher opened the weekly municipal refuse bags that stored discarded products to list and count HW found. The information that was captured on a datasheet included type, quantity and separation of hazardous waste from general waste.

Qualitative data was elucidated via multiple-choice questions. We limited potential biasness that could have been embedded in multiple choice questions by having an

option of ‘other’. When the desired answer was not mentioned on the list the respondents could opt for the ‘other’ option and then write the desired responds. In terms of attitude, respondents were presented with three choices, namely; positive, negative and neutral. Those who indicated they would never attend an information session on HW were categorised as negative, those who declared they might attend were categorised as neutral, while those who stated they would definitely attend were categorised as positive. Level of knowledge was documented as low, medium or high. Low was when respondents could not present information on any environmental and human health impact caused by HW. When interviewees could mention one cause, their responses were categories as medium, while if they could correctly name more than one, then their response was categorized as high. Participant’s knowledge on recycling was classified as partial, enough on or none. This response choice was based on participant’s own understanding of their knowledge level. A descriptive analysis was used because of the low number of available salons.

Residential areas

Observations, interviews and questionnaires were used to collect data on HHW management in the residential area of Musina. A semi-structured questionnaire was used to collect qualitative information, while a datasheet was employed to document quantitative data. The questionnaire gathered information on the demographic profile of the respondents such gender, age group and level of education as these parameters have a direct impact on waste management (Panyako *et al*., 2015). The questionnaire also requested information on HW management, attitude towards HW, and awareness of the impact of HW on the environment and human health. Convenience sampling was used for this study. This method was deemed appropriate for this study due to time limitations.

Observations were used to identify the types and document quantity of HHW discarded by all households. The researcher opened the weekly municipal refuse bags that stored discarded products to list and count hazardous products found. The information that was captured on a datasheet included type, quantity and separation of HW from general waste.

Qualitative data was elucidated via multiple-choice questions. In terms of attitude, respondents were presented with three choices, namely; positive, negative and

neutral. Those who indicated they would never attend an information session on HW were categorised as negative, those who declared they might attend were categorised as neutral, while those who stated they would definitely attend were categorised as positive. Level of knowledge was documented as low, medium or high. Low was when respondents could not present information on any environmental and human health impact caused by HHW. When interviewees could mention one cause their response were categories as medium, while if they could correctly name more than one, then their response was categorized as high. Participants' knowledge on recycling was classified as partial, enough or none. This response choice was based on participant's own understanding of their knowledge level.

A reliable database of waste characteristics is essential to a comprehensive and informative evaluation of management options in all waste management programs (Chang and Davila, 2008). Classification was carried out in this study in several dimensions such as normalized composition, type and purpose. This study classified HHW into the five major categories of home cleaning products, personal care products, gardening, automotive maintenance and miscellaneous items.

Industrial area

Observations, interviews and questionnaires were used to collect data on HW management in the industrial area of Musina. A semi-structured questionnaire was used to collect qualitative information, while a datasheet was employed to document quantitative data. The questionnaire gathered information on the demographic profile of the respondents such as gender, age group and level of education as these parameters have a direct impact on waste management, according (Panyako *et al*., 2015). The questionnaire also requested information on HW management, attitude towards HW, and awareness of the impact of HW on the environment and human health. Convenience sampling was used for this study. This method was deemed appropriate for this study due to time limitations.

Observations were used to identify the types and document quantity of HW discarded by all automotive workshops. The researcher opened the weekly municipal refuse bags and storage container that stored discarded products to list and count hazardous products found. The information that was captured on a datasheet included type, quantity and separation of HW from general waste.

Qualitative data was elucidated via multiple-choice questions. In terms of attitude, respondents were presented with three choices, namely; positive, negative and neutral. Those who indicated they would never attend an information session on HW were categorised as negative, those who declared they might attend were categorised as neutral, while those who stated they would definitely attend were categorised as positive. Level of knowledge was documented as low, medium or high. Low was when respondents could not present information on any environmental and human health impact caused by HW. When interviewees could mention one cause their response were categories as medium, while if they could correctly name more than one, then their response was categorized as high. Participants' knowledge on recycling was classified as partial, enough on or none. This response choice was based on participant's own understanding of their knowledge level.

### 3.5 DATA ANALYSIS

Close-ended responses was analysed via descriptive statistics, using Microsoft Excel software 2016. This method of analysis allowed the researcher to create meaningful reports and extract insights. Open-ended responses that were similar were manually coded to generalize on the responses and then analysed using Microsoft Excel as well. The data was presented using graphs, tables and paragraphs in order to provide visual interpretations and to draw conclusions for the obtained data with minimum statistical deviation.

The researcher analysed data by applying these set steps in order describe the data:

- Type data into Excel
- Click data tab, then data analysis in the analysis group
- Highlight descriptive statistics
- Type an input range into the input range text box
- Check the labels in the row
- Type a cell location into the output range box
- Use summary statistic check box and then display Excel descriptive statistics.

### 3.6 ETHICAL CONSIDERATIONS

The ethical guidelines of the Turfloop Research Ethics Committee were adhered to Ethical Clearance No: TREC/64/2020: PG. Participants gave their informed consent

before commencing with the interview schedules as required by the University of Limpopo's ethics committee. Consent was obtained from managers of beauty salons, homeowners and managers of automotive workshops prior to examining their refuse bags.

### 3.8 VALIDITY AND RELIABILITY OF THE STUDY

For the quantitative quality review with respect to validity, the researcher ensured that the research problem and concept are accurately measured by the questionnaire. Validity is defined as the extent to which a concept is accurately measured in a quantitative study. For example, a survey designed to explore depression, but which actually measures, anxiety would not be considered valid (Heale and Twycross, 2015). Reliability in qualitative research, according to Cameron (2010), refers to the degree of consistency with which a research tool measures what it is supposed to measure. Reliability was ensured by asking the exact same questions in all the questionnaires administered to all the participants. Lastly, objectivity and truthfulness are critical to both research traditions. However, the criteria for judging a qualitative study differ from quantitative research. Primarily, the researcher seeks believability, based on coherence, insight and instrumental utility (Eisner, 1991) and trustworthiness (Lincoln and Guba, 1985) through a process of verification rather than through traditional validity and reliability measures.

### Summary

Chapter 3 presents the context in which the study was conducted, and the research methods adopted for data collection and presentation. It further divides the study area into three study sites.

# CHAPTER 4

# DATA PRESENTATION ANALYSIS

## 4.1 INTRODUCTION

This chapter presents the findings obtained from the three-study site. The findings include the demographic profile of the participants, types and quantity of hazardous waste discarded and the management of hazardous waste across the three-study site. The analysis involves descriptive analysis in which the maximum, minimum and mean average was determined.

## 4.2 DEMOGRAPHIC PROFILE OF PARTICIPANTS

The salon owner sample consisted of 75% males. Eighty-eight percent (88%) of respondents were between 19-35 years. Though all participants had a formal school education, half of them had a high school certificate; meaning they completed Grade 12 (Table 4.1).

Residential owners consisted of 54% females. Fifty-five percent (55%) of respondents were adults between 36-59 years old, while 18% were pensioners over 60. Though all participants had a formal school education, almost half of them had a high school certificate; meaning they completed Grade 12 (Table 4.1).

Automotive business owners were all males. Fifty percent (50%) of respondents were between 19-35 years old, while 20% were pensioners over 60. Almost all (90%) participants had a formal school education, with 60% of them having a high school certificate; meaning they completed Grade 12 (Table 4.1).

Table 4.1 Demographic profile of study owner participants.

| | | **Salons** | | **Residential** | | **Automotive** | |
|---|---|---|---|---|---|---|---|
| **Variables** | **Categories** | **N** | **%** | **N** | **%** | **N** | **%** |
| Gender | Male | 6 | 75 | 30 | 54 | 10 | 100 |
| | Female | 2 | 25 | 25 | 46 | 0 | 0 |
| Age group (yrs) | 19-35 | 7 | 88 | 15 | 28 | 5 | 50 |
| | 36-59 | 1 | 12 | 30 | 54 | 3 | 30 |
| | >60 | 0 | 0 | 10 | 18 | 2 | 20 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Level of education | Formal education | 8 | 100 | 55 | 100 | 9 | 90 |
| | Primary school | 2 | 25 | 5 | 9 | 1 | 10 |
| | High school | 4 | 50 | 9 | 16 | 6 | 60 |
| | Higher certificate | 1 | 12.5 | 13 | 24 | 2 | 20 |
| | Diploma | 1 | 12.5 | 20 | 36 | 0 | 0 |
| | Honours | 0 | 0 | 1 | 2 | 0 | 0 |

## 4.3 TYPE AND QUANTITY OF HAZARDOUS WASTE PRODUCTS DISCARDED

### 4.3.1 Salons

The type and quantity of HW products disposed of on a weekly basis varied between salons (Figure 4.1). For example, all salons discarded hair food (colloquial items of creams and sprays used to smooth African hair, revitalise hair or to make the hair shiny) containers on a weekly basis. The least discarded HW product was plastic combs, with only 38% of salons discarding this item. The most discarded HW products were nail glass varnish bottles, with 250 bottles recorded amongst the eight salons, while the minimum was plastic combs with 4, among the eight salons. The average number of HW products that were found in the municipal refuse bag on a weekly basis is 66, consisting of items indicated in Figure 4.1.

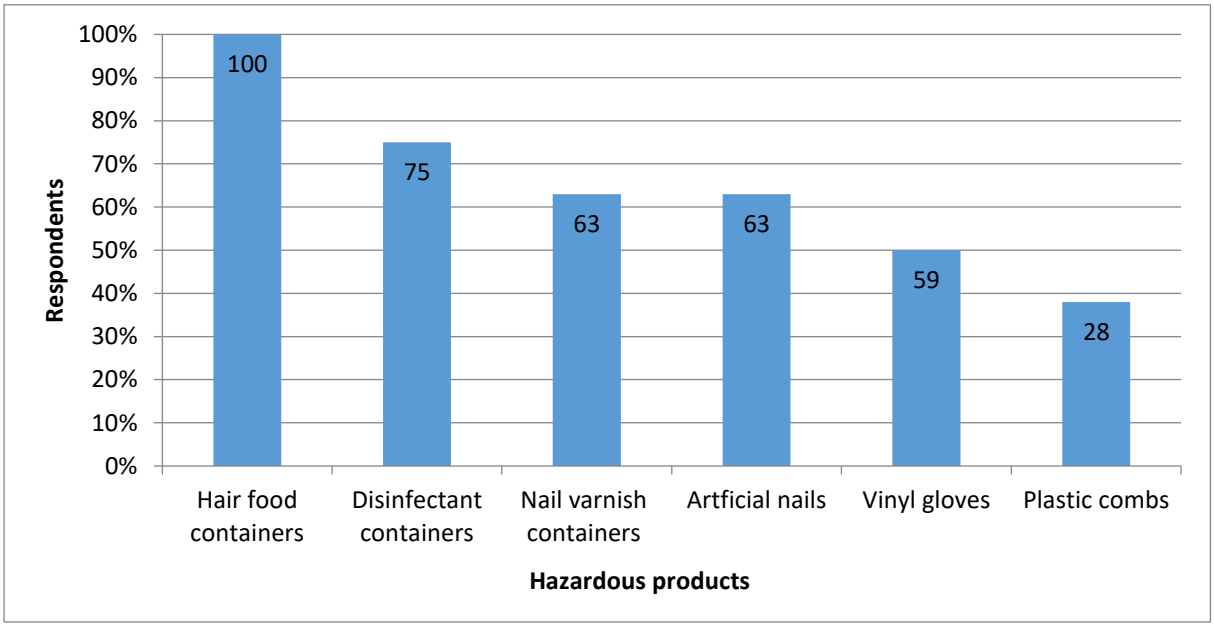


Figure 4.1 Type and percentage of hazardous products discarded by salons.

Hair food containers

All eight salons discard hair food containers (consisting of metal or plastic containers with residual sprays or creams – Figure 4.2) on a weekly basis, with a total of 70 found across all salons. The maximum number of hair food containers discarded by a salon was 9, while the minimum was 3 for a salon. In general, the number of these containers being disposed of ranged from 5 to 8, with a mean of 8.75 across the eight salons per week.


Figure 4.2 Discarded hair food containers.

Disinfectant containers

Six of the eight salons discarded disinfectant containers (consisting of plastic containers with residual aerosol or liquid sprays) on a weekly basis. A total of 29 containers were found amongst these six salons. The maximum number of disinfectants containers discarded were 7 by a salon, while the minimum was 3 for a salon. The number of these containers disposed of ranged from 4 to 6, with an average of 4.83 across the six salons

Nail varnish containers

Five of the eight salons threw away nail varnish containers (Figure 4.3), consisting of glass bottles, plastic applicators and caps; and residual varnish) on a weekly basis. A total of 250 bottles were found across the five salons. The maximum number of nail varnish discarded were 67 by a salon, while the minimum was 37 bottles for a salon. The number of these nail varnish bottles ranged from 41 to 55 amongst salons, with a mean of 31.25 across the eight salons.

Figure 4.3 Discarded nail varnish containers.

Artificial nails

Five of the eight salons discarded old artificial nails (consisting of nails, which can consist of acetone (used to remove old nails), acrylic or gel nails, and glue that was used to apply the nails) on a weekly basis. A total of 170 artificial nails were found across these five salons (Figure 4.4). The maximum number of artificial nails discarded was 38 by a salon, while the minimum was 29 for a salon. The number of these nails ranged from 32 to 36, with a mean of 34 across the five salons.

Figure 4.4 Discarded artificial nails and associated containers.

Vinyl gloves

Four of the eight salons disposed of vinyl gloves on a weekly basis. Thirty-eight vinyl gloves were found in refuse bags across these four salons. The maximum number of vinyl gloves discarded were 12 for a salon, while the minimum were 8 for a salon. The number of these vinyl gloves ranged from 8 to 36, with an average of 10 across the four salons.

Plastic combs

Three of the eight salons discard plastic combs on a weekly basis, resulting in a total of 4 plastic combs found. The maximum number of plastic combs discarded was 2 for a salon, while the minimum was 1 for another 2 salons.

### 4.3.2 Household

The type and quantity of HW products disposed of on a weekly basis varied between households (Figure 4.5). For example, all household discarded home cleaning products (colloquial term for laundry and dishwater detergent; soap bars, air fragrance, wood protector and all-purpose cleaner) metal and plastic containers on a weekly basis. The least discarded HHW product was gardening products such (chemical fertilizer, pesticides, herbicides), with only 10% of households discarding this item. The most discarded HW products were personal care products, with 237 containers recorded amongst 48 of the 55 households, while the minimum was gardening containers and plastics with found among 8 of the 55 household. The average number

of HW products that can be found in the municipal refuse bag on a weekly basis is 12 consisting of the following items indicated in (Figure 4.5)

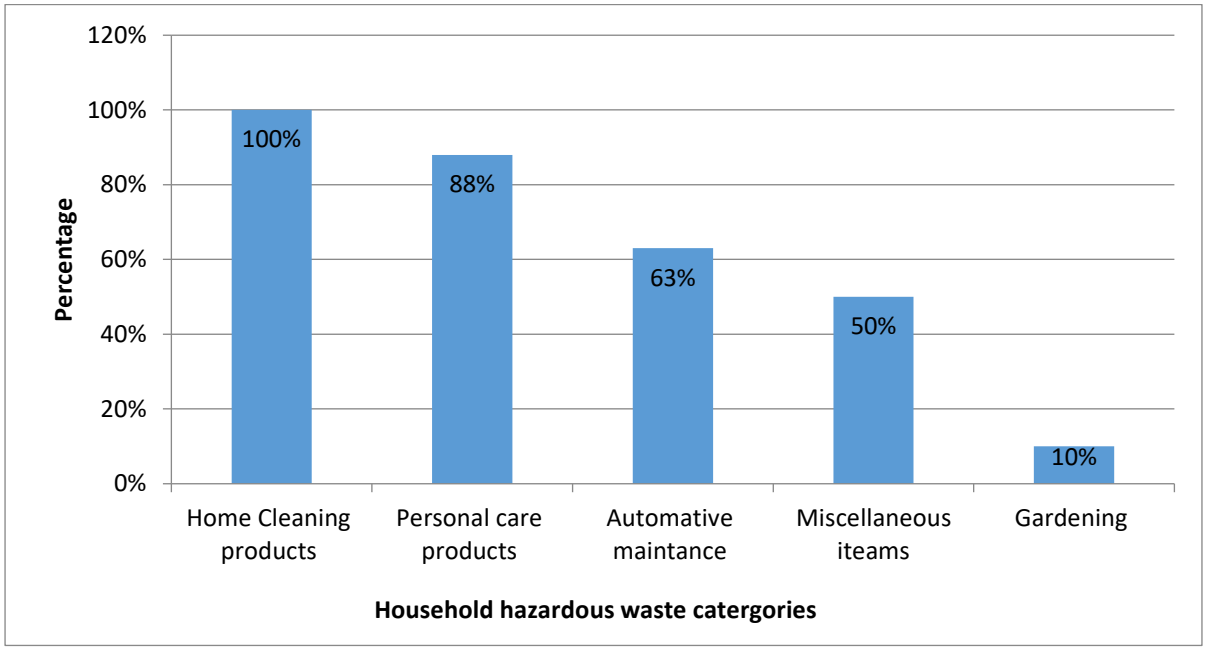



Figure 4.5 Type and percentage of household hazardous products discarded by the participants.

Home cleaning products

All 55 households discard home-cleaning product (consisting of metal or plastic containers with residual sprays or creams) on a weekly basis, with a total of 237 found across all households. The maximum number of home cleaning containers discarded by a household was 11, while the minimum was 4 with a mean of 4.4 across all sampled households.

Personal care products

Forty-eight households discarded personal care products (such as hair spray, lotion, perfume, toothpaste) on a weekly basis. A total of 265 containers including bottle sprays, residual aerosols, and liquid sprays, amongst others were found discarded in the trash bins of the 48 households. The maximum number of the personal care product was 15 containers, while the minimum was 3. The mean average was 5.58 across the 55 households.

Automotive maintenance products

Twenty of the 55 households discarded automotive maintenance products such as oil containers, break fluids, lubricants containers on a weekly basis. Thirty-five 35 automotive products (Table 4.2) were found across 20 households. The maximum number of automotive products discarded by a household was 6, while the minimum was 1, with a mean of 1.75 across the 20 households.

Table 4.2 Types of automotive products discarded in the suburbs of Musina

| **Automotive Product** | **Quantity** |
|---|---|
| Anti-freeze | 13 |
| Oil container | 9 |
| Floor mats | 5 |
| Break fluids | 8 |

Miscellaneous items

Twenty-seven of the 55 households threw away miscellaneous products such as fluorescent tubes, ink cartridge and tonner glue on a weekly basis. A total of 67 products (Table 4.3) were found across the 27 households. The maximum number of miscellaneous items discarded by a household was 5, while the minimum was 2 with a mean of 2.48 across the 27 household.

Table 4.3 Type of miscellaneous items discarded in the suburbs of Musina

| **Products** | **Quantity** |
|---|---|
| Florescent tubes | 7 |
| Pool chemicals | 30 |
| Ink cartridge | 5 |
| wooden glue | 5 |
| Glass bottles | 10 |
| Paint containers | 10 |

Gardening

Ten of the 55 households disposed of gardening product such as insecticides pesticides, and oil fertilizer on a weekly basis. Thirteen gardening plastic products

containers were found in refuse bags across these 10 households. The maximum number of gardening products discarded by a household was 3, while the minimum was 1 for a household, with an average of 1.3 across 10 households.

### 4.3.3 Automotive workshop

The type and quantity of HW products disposed of on a weekly basis varied between different automotive workshops (Figure 4.6). For example, all automotive workshops discarded plastic components such as (wiper blades, bumper, pedals, rear view mirror, mud flaps and seat belt containers) on a weekly basis.

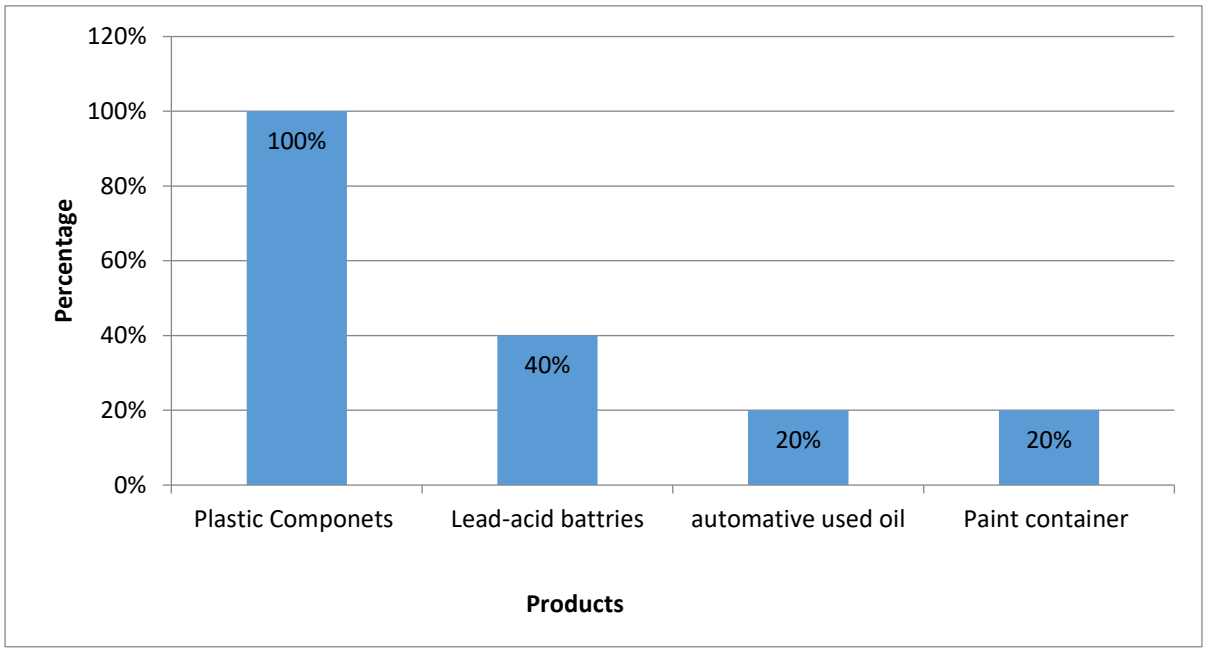



Figure 4.6 Type and percentage of hazardous products discarded by automotive workshop.

Plastic Components

All 10 automotive workshops discard plastic components (consisting of bumper, wiper blades and seat belts amongst others) on a weekly basis, with a total of 31 components found across all workshops. These plastic components are taken to the landfill site by the employers while some are taken to recycling facilities. The maximum number of plastic components discarded by an automotive workshop was 6, while the minimum was 3 with a mean of 3.1 across all sampled workshop. The table below (Table 4.4) illustrate the breakdown of different components with the quantity.

Table 4.4 Type and quantity of hazardous plastic components discarded

| **Plastic components** | **Total quantity** |
|---|---|
| Wiper blades | 8 |
| Bumper | 7 |
| Pedals | 6 |
| Rare view mirror | 4 |
| Mud flaps | 4 |
| Seat belt | 2 |

Lead-acid battery

Four of the 10 automotive workshop discarded lead-acid battery on a weekly basis. Seven lead-acid batteries were found across these 4 workshops. The maximum number of lead-acid battery discarded by a workshop was 3, while the minimum was 1 with a mean of 0.7 across the 10 automotive workshops.

Paint containers

Two of the 10 automotive workshops threw away paint containers with some residue on a weekly basis. A total of 5 containers were found across the two automotive. The maximum number of paint containers discarded by an automotive workshop was 3, while the minimum was 2 with a mean of 0.2 across the automotive workshop.

Automotive used oil.

Only two automotive workshops disposed of used oil on a weekly basis. Approximately 10l of used oil was found stored and ready for collection on the sampled week.

## 4.4 RESULTS

The state and management of hazardous waste discarded by households located at the suburbs of Musina, Limpopo Province, South Africa

### 4.4.1 Management of hazardous waste in salons

#### 4.4.1.1 Separation of waste

None of the participating salons separate different types of waste at source. Thus, HW was thrown together with biological waste and other non-HW in a refuse bag. Lack of awareness (38%) was of the main reasons why participants didn’t separate their

waste. Other reasons put forth included lack of incentives (25%), not having enough bins (25%), and not enough time to separate different types of waste (12%).

#### 4.4.1.2 Temporary storage and final disposal method of hazardous waste products

All salons used the same method for temporary storage and disposal. Salons temporary store their waste in municipal refusal bags. Once a week, a municipal garbage truck collects the waste, and transports it to a municipal landfill site for final disposal. Figure 4.7 shows how hazardous products from the salon are temporary stored.

Figure 4.7 Temporary storage of hazardous waste discarded by salons.

#### 4.4.1.3 Attitude, knowledge and awareness on the management of hazardous waste

##### 4.4.1.3.1 Attitude towards up-skilling

Half of the participants indicated that they might attend a hazardous waste workshop, while 25% would attend, and another 25% would not attend due to time constraints.

##### 4.4.1.3.2 Knowledge of recycling and environmental and human health impact

On the issue of recycling, half of the respondents only had partial knowledge on the concept of recycling, while 38% indicated they did not have any knowledge regarding recycling. Only 12% claimed to have adequate knowledge of recycling.

Five out of eight (63%) participants failed to identify at least one environmental or human health impact associated with HW products. Two (25%) participants managed to name just one environmental or health impact. Only one (12%) participant could present both an environmental and health impact associated with HW products.

#### 4.4.1.3.3 Awareness of hazardous waste

The percentage of respondents who were not aware that the waste they discard is hazardous was 75%. 25% of the respondents agreed with a statement that they could improve on their waste, especially HW, management if they were provided with the necessary support. 63% of the study participants regarded recycling of HW as very important, while 12% viewed it as unnecessary. The remaining 25% were unsure on the importance of recycling.

## 4.5 RESULTS

The state and management of hazardous waste discarded by households located at the suburbs of Musina, Limpopo Province, South Africa

### 4.5.1 Management of hazardous waste in household

#### 4.5.1.1 Separation of waste

None of the participating households separate different types of waste. Thus, HHW was thrown together with biological waste and other non-HW in a bin. Lack of awareness (36%) was one of the main reasons why participants did not separate their waste. Other reasons put forth included lack of incentives (22%); not having enough time (22%), not enough bins (11%), and finally that there was no space in the yard (9%).

#### 4.5.1.2 Temporary storage and final disposal method of hazardous waste products

Ninety-one of the households practice the same temporary method; participants' temporarily store their waste inside the house bins (usually pedal bins) and once the bin is full, they dispose it to the outside wheelie bins. The remaining five houses discarded their waste directly into the outside wheelie bin without first storing it inside the house. The disposal methods are the same, once a week a municipal garbage truck collects the waste and transports it to a municipal landfill site for final disposal.

Figure 4.8 Municipal garbage truck collecting waste once a week

#### 4.5.1.4 Attitude, knowledge and awareness on the management of hazardous waste

##### 4.5.1.4.1 Attitude

Forty-two percent of the participants indicated that they might attend a hazardous waste workshop if was to be provided; while the 33% indicated that they will attend. The remaining 25% indicated they wouldn't attend due to time constrains.

##### 4.5.1.4.2 Knowledge of recycling and environmental and human health impact

Almost half (52%) of the respondents only had partial knowledge on the concept of recycling, while 30% indicated they have adequate knowledge. Only 18% didn't have any knowledge on the concept of recycling.

Thirty-two (58%) participants managed to name just one negative environmental or human health impact. Only 14 (26%) participants could present both an environmental and human health impact associated with HHW products. The remaining 9 (16%) participants failed to identify at least one environmental or human health impact associated with HHW products.

#### 4.5.1.4.3 Awareness of hazardous waste

The percentage of respondents who were not aware that the waste they discard is hazardous was 27%. Eighty-five percent of the respondents agreed with a statement that they could improve on their waste, especially HW, management if they were provided with the necessary support. Sixty-three percent of the participants regarded recycling of HHW as very important, while 15% viewed it as unnecessary. The remaining 22% were unsure on the importance of recycling.

## 4.6 RESULTS

The state and management of hazardous waste discarded by automotive workshop located in the Industrial zone of Musina, Limpopo Province, South Africa.

### 4.6.1 Management of hazardous waste in automotive workshop

#### 4.6.1.2 Separation of waste

Only two of the 10 participating automotive workshops separate different types of waste at source. Thus, HW was thrown together with biological waste and other non-HW. A lack of awareness (60%) was one of the main reasons why participants did not separate their waste. Other reasons put forth included not enough bins (30%) and finally that there was no space in the yard (10%).

### 4. 6.1.3 Temporary storage and final disposal method of hazardous waste products

The Musina Local Municipality does not collect waste from automotive workshops therefore it is the responsibility of the owners to discard their waste in an environmentally friendly manner. Plastic components were discarded at the landfill site where lead-acid batteries were kept on site for recycling purposes. One automotive workshop burned the paint containers together with other waste while the other discarded the containers to the landfill site. The automotive workshop that used oil donated the oil to a local member in which the purpose of it is unknown.

#### 4.6.1.4 Attitude, knowledge and awareness on the management of hazardous waste

##### 4.6.1.4.1 Attitude

Sixty percent of the participants indicated that they will attend a hazardous waste workshop if provided, while 30% indicated that they might attend if they are available. The remaining 20% indicated they wouldn't attend and couldn't give any valid reasons.

##### 4.6.1.4.2 Knowledge of recycling and environmental and human health impact

Forty percent of the respondents only had partial knowledge on the concept of recycling, while the other 40% indicated they have adequate knowledge. Only 20% didn't have any knowledge on the concept of recycling.

Thirty percent of participants managed to name just one negative environmental or human health impact. Only 2 (20%) participants could present both an environmental and human health impact associated with HW products. The remaining 5 (50%) participants failed to identify at least one environmental or human health impact associated with HW products.

##### 4.6.1.4.3 Awareness of hazardous waste

The percentage of respondents who were not aware that the waste they discard is hazardous was 50%. Seventy percent of the respondents agreed with a statement that they could improve on their waste, especially HW, management if they were provided with the necessary support. Only 30% participants regarded recycling of HW as very important, while 20% viewed it as unnecessary. The remaining 30% were unsure on the importance of recycling.

**Summary**

Chapter 4 presents the research results. This chapter gives an outline on the type and management of hazardous waste discarded by the three-study zone. It clarifies the research methodology adopted for data collection.

# CHAPTER 5

# DISCUSSION, CONCLUSION AND RECOMMENDATIONS

## 5.1 DISCUSSION

The state and management of hazardous waste discarded by households located at the suburbs of Musina, Limpopo Province, South Africa.

### 5.1.1 Demographic profile of participants

Women have a higher probability to manage their waste than men. This may be due to women tend to care more on cleanliness and health and are thus more enthusiastic on waste management (Handayani et al., 2018). Although none of the participants separate waste, most women highlighted that it is because of insufficient bins and not enough space in the yard for bins. This substantiates that women are willing to separate waste they are just resources constrained, unlike men who expected incentives in return to separate waste. Abila and Kantola (2019) in their study on financial reward for recycling waste, noted that 62.6% of participants agreed that a financial incentive is the main trigger of behavioural change, while 52.8% of the participants agreed that this incentive stimulates knowledge about recycling waste. The study recommends that the municipality partners with interested stakeholders to have a recycling facility. Community members will then get to exchange their recyclable material for monetary or credit value. This will bring about positive change in attitude since incentives is also an issue.

The study found out that 70% of participants aged above 60 are willing to attend a hazardous workshop as compared to the 67% of participants aged 18-35 who stated that they won't attend. Similar to the findings of Sidique et al. (2010), our results confirm that older people are more likely to be involved in recycling and waste management programs. This might be because older people have enough time (due to retrenchment) unlike the age group between 18-35 who are busy with either academics or work related. The study, therefore, suggest that the municipality look in arranging a number of repetitive hazardous awareness workshops. This will enhance attendance because people will have options to attend based on the day that they are not busy.

Education is widely believed as important factor to shape pro-environmental behaviour of households (Mwanza et al., 2018). Our study found out that majority (80%) of the

people who agreed that recycling is important are those with at least Diploma Certificate and higher. A similar conclusion was reached by Miller et al. (2009) that if the percentage of people who are 25 years and older with a bachelor's degree or higher increases by 1%, then recyclable volumes increase by 0.7%. Therefore, the study recommends that the Musina Local Municipality takes into account the demographic characteristics of the community; this will help to better aim policies and campaigns oriented to promote environmentally responsible behaviour to particular population group region.

### 5.1.2 Type and quantity of hazardous waste products discarded in salons

Salons located in the CBD of Musina dispose different types of HW products. This included hair food containers, disinfectant containers, nail varnish containers, artificial nails, vinyl gloves and plastic combs. These chemical products are similarly to those documented by Omokhodion *et al*. (2009) and Adewumi (2015) for salons in Nigeria and the United States of America respectively. Bigambo (2017) found that most of the products used in Dar es Salaam, Nigeria, salons can be classified as hazardous. The same applies to salons in the Musina CBD thus extreme caution should be taken when using these products, which implies that users must be trained and certified to handle and dispose these products, which is not the case for African salons (Bigambo, 2017).

The average number of HW products that can be found in the municipal refuse bag on a weekly basis is 66. This means the projected estimation of HW products found in a month from all eight salons is 264 and approximately 3168 HW products in a year. After an exhaustive search no comparative literature could be found on quantities of HW produced by beauty salons. Thus, this is a first attempt at quantifying HW discarded by beauty salons.

Disinfectants and their containers

Twenty-nine disinfectants were discarded per week by six salons of the eight investigated salons. This equates to 116 disinfectants per month and 2668 per year. Disinfectants are chemical liquids that destroy bacteria and prevent their multiplication. They are considered hazardous products because they contain chemicals such as ethylene, which is highly flammable and explosive (Labour Department, 2007). Although the demand for more effective cleaning and disinfecting is growing, there is

also increasing evidence that exposure to cleaning disinfectants can cause acute illnesses (Lee *et al*., 2014) and chronic health effects particularly respiratory illness (Arif and Delclos, 2011). Other adverse human health effects, including dermal and respiratory sensitization, dermal and respiratory irritation, work-related asthma, chronic bronchitis, and sensitization (Quinn *et al*., 2015). A report by the World Health Organization (WHO, 2000) confirmed that although terrestrial organisms are much less likely to be exposed to ethylene, a high concentration may have toxic effects on yeasts and fungi from soil, which inhabits their ability to breakdown biological litter. Furthermore, it can strain the germination of seeds.

Most commercial cleaning products are also packaged with the intention to be disposed of after use. Though these plastic containers are technically recyclable many people simply discard them when empty. The reasons this study found for this action is indicated under section 3.4 (Attitude, knowledge and awareness on the management of hazardous waste). Since these plastics are not biodegradable it occupies landfills for a long time and accumulates in large quantities over the years (Luyt and Malik, 2019).

The hazardous chemicals identified are not only used as the main ingredient (monomer) to produce the plastic packaging but are also used for a range of functions from biocides to prevent moulds, flame retardants to increase fire resistance, plasticizers to increase flexibility, dyes, adhesives and others. A group of additives to plastics, that consists of substances containing hazardous metals. Four of the heavy metals, cadmium, chromium(VI), lead and mercury; are considered to be highly hazardous to human health because they are carcinogens and can cause permanent changes to the genetic make-up of cells, or they can have adverse effects on fertility and sexual function (Watson, 2018).

Phthalate is one of the hazardous chemicals found in plastic container such as food packaging; they are added to polyvinyl chloride to improve its flexibility and hardness. (Fierens *et al*., 2012). Phthalates, or esters of phthalic acid, are toxic (Grynkiewicz, 2011). Leachate is mostly generated through penetration of precipitated water into the landfill. Phthalate are easily released from waste and can be found in high concentrations in landfill leachate (Gao and Wen, 2016).

Nail varnish and their containers

Nail varnish is a lacquer that is applied to human nails for decorative purposes or to protect the nail plate. This lacquer consists of hazardous chemicals such as toluene, fomaldehyde and dibultyl phthalate, while the glass consists of harmful components such as lead, and the applicator is constructed from toxic chemicals such as bisphenols. Notwithstanding their toxicity, nail varnish is widely used around the world. However, their environmental impact and ultimately human health consequences is yet to be fully understood (Felzenswalb *et al*., 2018). When the glass containers of nail varnish decompose at landfills and release their residual lacquer and plastic applicators into the soil and ground water (Putosis, 2015), their impact on the environment range from degrading of soil (Turpie *et al*., 2019) to contamination of water (UNEP,2018).

Furthermore, once in the ecosystem, toluene, fomaldehyde and dibultyl phthalate can harm the central nervous system, damage reproductive organs of humans and animals, and cause cancer, which could potentially lead to fatalities (Bachand *et al*., 2010). Thus, it is abundantly clear that these HW products pose a significant environmental and human health risk. Therefore, there is an urgent need by the Musina Local Municipality to institute mitigating measures to reduce the risk to environmental and human health that stem from the extensive use (the 250 bottles documented per week result in in a projection of 1000 per month and 12000 per year) and casual manner (mixing them with other waste) in which this HW product is discarded.

Artificial nails

Artificial nails are pre-cut pieces of plastic used to enhance natural nails or for decorative purposes (Toles, 2002). Our results show 170 artificial nails were discarded per week by five salons of the eight investigated salons. This equates to 680 nails per month or 8160 per year. One of the most hazardous chemicals found in artificial nails is methyl methacrylate (MMA), which is highly flammable (White *et al*., 2015). This combustibility feature is problematic in landfill sites that as a rule generate heat via the action of microorganisms. Furthermore, if inhaled, MMA can cause respiratory irritation and laboured breathing in people located near landfill sites, which may progress into

asthmatic symptoms. Additionally, it may induce narcotic effects such as drowsiness or dizziness. Furthermore, based on non-human toxicity studies, acute exposure to MMA may result in kidney and liver lesions resembling those caused by carbon tetrachloride (Acero, 2017).

Vinyl gloves

The best way to protect skin from the chemicals salons are using is by wearing gloves (Predolich, 2017). This is because vinyl gloves are considered a HW product because they contain phthalates (Jonsson *et al*., 2013). Phthalates are readily released into the environment where they can cause reproductive toxicity in humans and animals, leading to infertility and reproductive problems (Przybylinska and Wyszkpwski, 2016).

Although Bigambo (2017) states that it is a good idea to use gloves whenever handling chemicals, especially irritating chemicals (such as those in beauty salons), only half of the respondents in this study used gloves. This was directly correlated to the level of education. Of the 50% of the participant that didn't use gloves 25% had only a primary level schooling while the other 25% had high school level of education. The uses of gloves were again correlated with knowledge on the impacts of HW products. It was found that the 50% of participants that didn't use gloves also formed part to the participant cohort who failed to identify any impacts associated with hazardous waste thus categorized as low knowledgeable participants. Thus, it is recommended that the Musina Local Municipality sets standard regulations that includes the use of gloves as compulsory thereafter an inspection can be done per schedule to monitor the level of compliances.

Plastic combs

Although this study found that this is a HW product not frequently thrown away (n=4 per week, equating to a projected 16 per month, and 192 per annum), discarding them do add to the already substantial quantities of plastic that have accumulated in the natural environment and landfills. Barnes *et al*. (2009) noted that around 10% by weight of the municipal waste stream is plastic. Thompson *et al*. (2009) indicated that a range of chemicals used in the manufacture of plastics are known to be toxic and have negative environmental and human health implications. Thus, this study recommends that beauty salons switch to wooden combs to avoid the environmental impacts associated with plastic.

Hair food and their containers

All eight salons discard different types of residual hair food and their containers, which negatively affects the environment. Although hair food per se is not seen as harmful to the environment and human health, seeing that they mostly consist of natural ingredients such as shea butter, coconut oil, Aloe Vera, jojoba extract, and extra virgin olive oil (Essence, 2019), amongst other, it is their containers that constitute a significant environmental health problem. Seventy containers were found across all salons per week, which equates to 280 per week and 3360 per year.

These containers are mostly made from hard plastics that break down over time into micro-pellets in landfill sites, which can enter the ecosystem, negatively affecting the soil fauna, and ultimately human health (Geyer *et al*., 2017). Thus, the study recommends that beauty salon owners opt for eco-friendly products. The greener the product is, the easier it should be to dispose of since sustainability will be factored into the packaging.

### 5.1.2 Management of hazardous waste in salons

#### 5.1.2.1 Separation of waste

Proper waste separation does not only increase the recycling rate, but also reduces the volume of waste and ultimately detrimental impacts on the environment (Matter *et al*., 2013). Thus, it is of concern when none of the participants in our study separate waste. The findings of current study indicated that the main reason of not separating waste was due to lack of awareness, lack of incentives, not having enough bins and not having enough time. The results are similar to Babazadeh *et al*. (2018) who found that, the four main barriers and challenges for implementing the source separation are problem in waste collection system, lack of responsibility among citizen, insufficient awareness amongst the citizen, and expectations of receiving incentives. Currently, beauty salon waste is not treated differently from other wastes by the local authorities. All wastes are temporary stored in refusal bag and are transported to the landfill site for final disposal. Therefore, the Musina Local Municipality need to investigate these four issues when formulating a recycling plan for the town.

Lack of awareness

The main reason for not separating waste, especially HW, by respondents in our study, was due to a lack of awareness. Most respondents were not fully aware about the importance of separating waste or the environmental and human health consequences thereof. This is in line with Chu *et al*. (2013) who also reported lack of awareness as an influential barrier for the realization of citizens' participation in recycling schemes. Glanz (2008), noted that to comply with acceptable behaviour, awareness about the implications of the behaviour is necessary. Therefore, the Musina Local Municipality urgently need to implement educational programs that enhance the awareness of the beauty salon community about the importance of separating waste at source, especially HW.

Lack of incentives and time to separate waste

Similar to the findings of Babaei *et al*. (2015), respondents in the current study expected to receive incentives in exchange for delivering separated wastes. This might be an option to be investigated by the Musina Local Municipality. This is because in Thailand, the existence of financial incentive mechanisms increased the rate of waste separation by up to 51% among the households (Boonrod et al., 2015). Non-financial incentives that can be provided include supplying different coloured refusal bags and bins dedicated to waste separation. This ties in with claims from interviewees that they do not have enough bins for separation, hence their failure to separate different types of waste. By providing colour-coded bins and bags, the issue raised by the interviewed community of not having enough time to separate different types of waste will also be negated.

#### 5.1.2.2 Attitude, knowledge and awareness on the management of hazardous waste

##### 5.1.2.2.1 Attitude towards up skilling

Having the correct attitude is one of the fundamental keys to a sustainable waste management (Kumar *et al*., 2017). Not being enthusiastic to attend a hazardous workshop shows that some participants have an extremely negative attitude, and willing to change. Those who said they might attend were concerned about the running of the business when they were away. The Musina Local Municipality would need to

work around these concerns, probably by presenting awareness workshops after hours and over a shorter time period (e.g. 1-2 hours).

#### 5.1.2.2.2 Knowledge of recycling and environmental and human health impact

The lack of public knowledge on the environmental effects of waste has been reported as an important barrier to complying with the recommended health behaviour (Zhang *et al*., 2014). Also, having proper knowledge is one of the most powerful predictors for recycling behaviour among individuals (Babaei *et al*., 2015). Thus, it is important for participants who work with HW products to know its environmental and human health impacts. This includes human health problems such as skin irritation, cancer and asthma amongst other. The environmental impacts include soil contamination and land pollution. On recycling, the 12% that had knowledge on recycling had a diploma qualification this shows how important education is on the management of hazardous waste. Therefore, it is important that the Musina Local Municipality put emphasis on educating salon owners on the importance of recycling.

#### 5.1.2.2.3 Awareness of hazardous waste

Most of the participants were not aware that the products they dispose are hazardous. This leaves them unprotected from potentially hazardous chemicals. Therefore, extreme caution should be considered when dealing with this HW products. From the 75% that indicated that they are not aware that the products they produce are hazardous, 25% only reached primary level, while the remaining only had Grade 12. From this we can hypothetically conclude that the lower the level of education, the lower the awareness. It would hence forth be expected from the Musina Local Municipality prioritise making a prerequisite certificate for all salon owners and employees. This will increase their level of awareness regarding hazardous waste

## 5.2 DISCUSSION

The state and management of hazardous waste discarded by households located at the suburbs of Musina, Limpopo Province, South Africa.

### 5.2.1 Type and quantity of hazardous waste products discarded in houdehold

The type and quantity of HW products disposed of on weekly basis varies between households. The most discarded product is cleaning products while the least was gardening products. The types of households discarded are similar to that documented by Joshua *et al*. (2014). One of the problems with daily household products is that their chemical formulation is largely unknown to residence, both quantitatively and qualitatively. Therefore, it is reasonable to expect that the chemical brew produced in a landfill matrix is altogether difficult to stabilize and able to produce substance with stronger damaging effects (Slagsted and Brattebo, 2012). As a result, these types of waste stream require stringent control and management in order to protect the environment and human health from potential negative impacts (Ulinskaite *et al*., 2006). Thus, the study recommends that the Musina local Municipality develops a waste management plan that includes different waste streams and the volume of each stream. This waste management plan will help in understanding the variety waste streams discarded and how each waste stream can be managed in order to reduce the negative environmental impact and human health problems.

Home cleaning products

All 55 households discard home-cleaning product (consisting of metal or plastic containers with residual sprays or creams) on a weekly basis, with a total of 237 found across all households. These cleaning products such as automatic dishwashing detergents, non-oxygen laundry bleach, disinfectant cleaners, mildew removers, and toilet bowl cleaners are associated with many health and environmental problem (Martinez-Pena *et al*., 2013). Several studies have investigated the relationship between adverse health effects, cleaning activities and cleaning products (Dumas et al., 2012). Breathing in the fumes of cleaners containing high concentrations of chlorine can irritate the lungs of landfill site scavengers. Other health impacts associated with being exposed to chemicals found in cleaning products include contact dermatitis, asthma and other respiratory disorders (Bello et al., 2010).

The environmental impacts of residue left inside the container can get deep into the soil due to ground seepage and then absorbed by the groundwater used by wild growing trees. The chemical can lead to poor quality of natural veld (Alton, 2017). The study recommends that homeowners go green with cleaning products. Green cleaning refers to cleaning methods and cleaning products with environmentally friendly ingredients designed to preserve human health and environmental quality. When consumer purchases new cleaning products, they ought to look for manufacturers that list their natural ingredients on the label and purchase cleaners containing non-petroleum-based surfactants, that are chlorine and phosphate free, that claim to be “nontoxic” and that are biodegradable. These products often clean as effectively as their petrochemical counterparts, but don’t pollute your home in the process. The Musina Local Municipality can facilitate in educating homeowners on how to interpret different Safety data sheet (SDSs) in order to be able to know and identify environment friendly ingredient.

Personal care products

Forty-eight households discarded personal care products (such as hair spray, lotion, perfume, toothpaste) on a weekly basis. Cosmetic product means any substance or mixture intended to be placed in contact with external parts of human body or with teeth and mucous membranes with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance and/ or protecting them (Juliano and Magrini, 2017). Personal care products that were found included: hair spray, nail varnish, toothpaste, skin cream and bubble bath amongst others. These results are similar to that found in the study conducted by (Al-Tamimi *et al*., 2019).

The impact of some specific personal care products have been dealt with extensively in the previous chapter. There are certain additive chemicals that are found in the personal care products which are hazardous and have the potential to cause cancer, mutation, reproductive toxicity and endocrine disruption (Amasa *et al*., 2012). The beauty and personal care product industry is also largely responsible for causing toxic effects and damages to the environment and its inhabitants. The chemical components of many beauty and personal care products we use are accumulated in our eco-system killing all forms of life (Pumfrey, 2018). Over the last two years the cosmetic industry In South Africa has experienced growth rate of 4, 6% (Shand, 2017). Therefore, there is a need to manage and discard this type of waste stream since its

increasing rapidly. This can be achieved by homeowners buying eco-friendly product and recycling all the empty containers.

Automotive products

Twenty of the 55 households discarded automotive maintenance products such as oil containers, break fluids, and lubricants containers on a weekly basis. These products included antifreeze containers, metal polish with solvent, car wax, oil container and a battery. This type of waste bears numerous hazardous chemicals such as lead, arsenic, zinc hydrocarbons, cadmium and chromium (Terazono *et al*., 2015). The main routes of exposure and absorption of such chemicals are inhalation, ingestion and to a much lesser extent dermal contact (ATSDR, 2007). Exposure to Lead for example can cause hypertension in adults and pregnant woman (Cheng *et al*., 2001). Studies shows that young children are particularly vulnerable to the neurological toxicity of lead and this is the main reason that lead to public health concerns (WHO, 2017).

The oil and grease have been known to cause extensive damage to the environment. Used oil placed in landfill sites may seep throughout the bottom of such landfill and subsequently contaminating ground water supply and if it spills on land it can render the soil unproductive (The Austrian Government, 2019). The HHW stream components due to their hazardous toxic characteristics may adversely affect environment when handling, transferring or disposing, so they should be disposed in a special procedure (Hassanvand *et al*., 2011). Thus, the study recommends that homeowner who uses oil must get a drip tray to catch all the oil and this oil can be sent for recycling.

Miscellaneous items

Twenty-seven of the 55 households threw away miscellaneous products such as fluorescent tubes, pool chemicals, ink cartridge and tonner glue on a weekly basis. Pool chemicals for example, contain Sulphur which can damage vital organs such as liver, kidney and the heart. On the other hand electronic equipment and florescent tubes contain mercury and long term exposure can cause sensory impartment, dermatitis, memory loss and muscle weakness (Sankhla *et al*., 2016). Some of the Miscellaneous items contains cadmium which when not properly recycled it can leach to the soil, harming microorganisms and disrupting the soil ecosystem (Rajput, 2019).

Thus, the study recommends that the Musina Local Municipality encourages recycling amongst its resident in order to recycle some of the products.

Gardening

Ten of the 55 households disposed of gardening product such as insecticides pesticides, and oil fertilizer on a weekly basis. Although this study found that this is HW product is not frequently thrown away n=13 per week, equating to a projected 52 per month, and 324 per annum) the gardening chemical containers still had a little bit of residue. Gardening chemicals such as pesticides can cause a range of neurological health impacts such a loss of coordination and memory; reduced visual ability and reduce motor signaling (Lah, 2011). Unfortunately, pesticides can leech into the soil which affects the microbes residing in it. Soil dwelling microbes help the plants in many ways. Such as nutrient uptake, breakdown of organic matter and increasing soil fertility (Mahmood *et al*., 2016). Thus, the study recommends that homeowners should rinse empty concentrated containers three times, adding the washings to their final spray solution and then disposed of in general household waste. Containers that have held concentrated produce are not suitable for recycling.

### 5.2.2 Management of hazardous waste in household

#### 5.2.2.1 Separation of waste

Household hazardous waste (HHWs) must be separated from other domestic wastes and should not be disposed of together with municipal wastes because they require special treatment before disposal. (Edokpayi *et al*., 2017). Thus, it is of concern when none of the participants in our study separate waste. The findings of current study indicated that the main reason of not separating waste was due to lack of awareness, lack of incentives, not having enough bins, not having enough time and finally not enough space in the yard.

The results are similar to Babazadeh *et al*. (2018) who found that the four main barriers and challenges for implementing the source separation are problem in waste collection system, lack of responsibility among citizen, insufficient awareness amongst the citizen, expectations of receiving incentives. Therefore, the Musina Local Municipality need to look into these four issues when formulating a recycling plan for the town.

Lack of awareness

The main reason for not separating waste, especially HW, by respondents in our study was due to a lack of awareness. It is clear that majority of respondents were not fully aware about the importance of separating waste or the environmental and human health consequences thereof. This is in line with Chu *et al*. (2013) who also reported lack of awareness as an influential barrier for the realization of citizens' participation in recycling. Glanz (2008), noted that to comply with acceptable behaviour, awareness about the implications of the behaviour is necessary. Therefore, the Musina Local Municipality urgently need to implement educational programs that enhance the awareness of the beauty salon community about the importance of separating waste at source, especially HW.

Lack of incentives and time to separate waste

Similar to the findings of Babaei *et al*. (2015), respondents in the current study expected to receive incentives in exchange for delivering separated wastes. This might be an option to be investigated by the Musina Local Municipality. This is because in Thailand, the existence of financial incentive mechanisms increased the rate of waste separation by up to 51% among the households (Boonrod *et al*., 2015). Non-financial incentives that can be provided include supplying different coloured refusal bags and bins dedicated to waste separation. This ties in with claims from interviewees that they do not having enough bins for separation, hence their failure to separate different types of waste. By providing colour-coded bins and bags the issue raised by the interviewed community of not having enough time to separate different types of waste will also be negated.

#### 5.2.2.2 Attitude, knowledge and awareness on the management of hazardous waste

##### 5.2.2.2.1 Attitude towards up skilling

Having the correct attitude is one of the fundamental keys to a sustainable waste management (Kumar *et al*., 2017). Not being enthusiastic to attend a hazardous workshop shows that some participants have an extremely negative attitude, which they are not willing to change. For no apparent reason 23% indicated that they won't attend any hazardous workshop, while 42% indicated that they might attend although they said it will depend on their availability. The remaining 33% agreed that they will attend a hazardous waste workshop if it was to be provided. The Musina Local

Municipality would need to work around these concerns, probably by presenting awareness workshops after hours and over a shorter time period (e.g. 1-2 hours).

#### 5.2.2.2.2 Knowledge of recycling and environmental and human health impact

The lack of public knowledge on the environmental effects of waste has been reported as an important barrier to complying with the recommended health behaviour (Zhang *et al*., 2014). Also, having proper knowledge is one of the most powerful predictors for recycling behaviour among individuals (Babaei *et al*., 2015). Thus, it is important for participants who work with HW products to know its environmental and human health impacts. This includes human health problems such as skin irritation, cancer and asthma amongst other. The environmental impacts include soil contamination and land pollution. On recycling, the 30% that had knowledge on recycling had a diploma and above qualification this shows how important education is on the management of hazardous waste.

#### 5.2.2.2.3 Awareness of hazardous waste

Most of the participants were aware that the products they dispose are hazardous, but it seems like they just didn't know to what extent. It is important to fully understand the different type of hazardous waste as well as their impacts on human health and the environment. Majority of the 21% that weren't sure of about the importance of recycling had primary and high school education. From this we can hypothetically conclude that the lower the level of education the lower the awareness.

## 5.3 DISCUSSION

The state and management of hazardous waste discarded by automotive workshop located in the Industrial zone of Musina, Limpopo Province, South Africa.

### 5.3.1 Type and quantity of hazardous waste products discarded in automotive workshop.

Automotive workshops located on the industrial node of Musina dispose of different HW ranging from plastic components, lead-acid batteries, automotive used oil and paint containers. The types of HW products discarded are similar to those documented by Salihoglu and Salihogula (2016). Sharma *et al* (2016), highlighted that there is a need to come up with strategies to recycle waste from automotive workshop waste in order to minimize its negative impact on the environment.

Plastic components

All 10 automotive workshops discard plastic components (consisting of bumper, across all workshops. These plastic components are similar to those documented by Erdogan and Salihoglu (2018) for automotive industry in Turkey. Currently, plastic waste poses environmental and human health problems globally and especially for African countries, which have high proportion of mismanagement waste plastic and lack state of the art recycling facilities (Jambeck *et al*., 2018). Available statistic shows that approximately 630000 tonnes of plastic components are mismanaged in South Africa yearly (Jambeck *et al*., 2015) therefore there is a need to manage the disposal of plastic components thus the study recommends that the municipality invests in local recycling companies in order to minimise the plastic components going to the landfill site.

Lead-acid batteries

Four of the 10 automotive workshop discarded lead-acid battery on a weekly basis. Seven lead-acid batteries were found across these 4 workshops. Lead-acid batteries are secondary batteries (Meaning they are rechargeable). Domestically lead–acid batteries are regulated by the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEMWA) as an amended which is the central piece of legislation that is core to the management of waste in South African. They are considered to be hazardous because exposure to lead reduces the synthesis of haem, which is necessary for the production of red blood cells, resulting in anaemias (ATSDR, 2007).

The material contained in lead-acid batteries may bring lots of pollution accidents such as fire, explosion, poisoning and leaks which can damage the ecosystem (Zhang *et al*., 2016). To avoid leakage of chemicals from the batteries the study recommends that the automotive workshop should build a small bund wall with roofing to avoid batteries being exposed to different weather conditions and the bund wall should be a bit far from the operational site.

Used motor oil

Only two automotive workshops use oil on a weekly basis approximately 10 litters per week is donated to a local community member. Nowak *et al*. (2019) stated that, oil have negative impact on the environment and causes serious contamination of soils, groundwater and can accumulate in plant tissue as well as terrestrial and aquatic animals. Prolonged exposure to used motor oil can cause constant irritation on tissue and a damaged tissue can lead to development of diseases such as Bronchitis, Bronchopneumonia, Asthma, Emphysema and Tuberculosis (Kumar, 2017). It is estimated that South Africa generates about 120 million litters of used lubricant oil every year News24, 2019). This is a large amount of used oil that if not collected and recycled responsively, it could cause negative environmental impacts and human health problem. The study recommends that the municipality inspects the storage and disposal of used oil in each workshop. This can be done by checking that the containers that are used to store oil are clean and safely labelled and the usage of dip tray to avoid oil spillage (Figure 5.1) to the environment while operating vehicles. Furthermore, each automotive workshop should give an account of how and where they disposed of their oil. If it's collected for recycling, then they must provide a certificate from the recycling company or a disposal certificate.

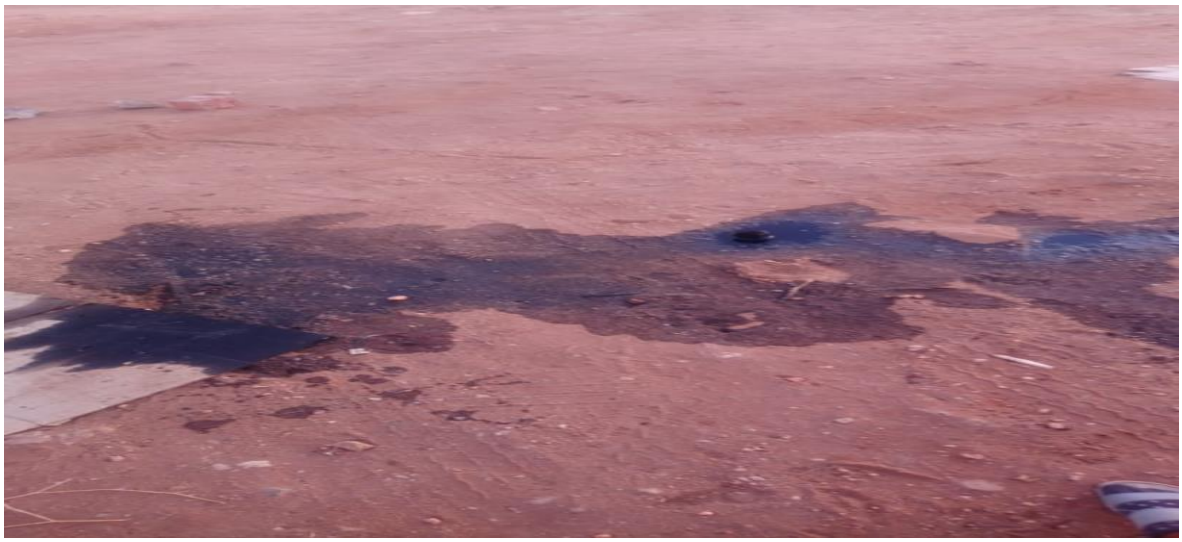


Figure 5.1 Oil spillage, contaminating the environment

Paint containers

Two of the 10 automotive workshops threw away 5 paint containers with some residue on a weekly basis. The result agrees with the literature of Geffen and Rothernberg, (2000), which reports that the primary source of hazardous waste at an automotive manufacturing plant is generally traced to a single unit operation; automotive painting. One automotive workshop burns their waste (Including paint containers) while the other takes it straight to the landfill site since they assume that it is totally empty. Prolonged or high exposure to paint and paint fumes can cause headaches, trigger allergies and asthmatic reactions, irritate skin eyes and put increased stress on vital organs such as the heart (Tina, 2015). Paint also contains Volatile Organic Compounds (VOCs) which when react with Oxygen can contribute to global warming (Stratford, 2020). Thus, the study recommends that the automotive workshop should opt for water-based paint with low titanium oxide and avoid paints with high level of organic solvents.

### 5.3.2 Management of hazardous waste in automotive workshop

#### 5.3.2.1 Separation of waste

Only two of the 10 participating automotive workshops separate different types of waste at source. Thus, it is of concern as only 20% of the participants in this study separate waste. The findings of current study indicated that the main reason of not

separating waste was due to lack of awareness, not having enough bins and finally not enough space.

Scientific research has observed that Industrial waste are not separated in origin into hazardous and no hazardous material (Olukunle and Okonkwo, 2015). Furthermore, developing countries lack regulations to deal with industrial hazardous waste and south Africa is not exempted; therefore, there is an urgent need to establish polices geared towards stimulating industries (Mmereki *et al*., 2016). To the best of our knowledge, there is no study that focuses on the separation of hazardous waste discarded by the automotive industry.

The results however are similar to Babazadeh *et al*. (2018), who found that the four main barriers and challenges for implementing the source separation are problem in waste collection system, lack of responsibility among citizen, insufficient awareness amongst the citizen, expectations of receiving incentives. Therefore, the Musina Local Municipality need to look into these four issues when formulating a recycling plan for the town.

Lack of awareness

The main reason for not separating waste, especially HW, by respondents in this study was lack of awareness. It is clear that majority of respondents were not fully aware about the importance of separating waste or the environmental and human health consequences thereof. This is in line with Chu *et al*. (2013), who also reported lack of awareness as an influential barrier for the realization of citizens' participation in recycling. Glanz (2008) noted that to comply with acceptable behaviour, awareness about the implications of the behaviour is necessary. Therefore, the Musina Local Municipality urgently need to implement educational programs that enhance the awareness of the automotive community about the importance of separating waste at source, especially HW.

Not enough bins

Rousta *et al*. (2017) claimed that in order to achieve a successful plan in terms of waste separation at source, a collecting system must be provided. This ties in with claims from interviewees that they do not having enough bins for separation, hence their failure to separate different types of waste. By providing colour-coded bins and

bags the issue raised by the interviewed community of not having enough bins to separate different types of waste will also be negated.

#### 5.3.2.2 Attitude, knowledge and awareness on the management of hazardous waste

##### 5.3.2.2.1 Attitude towards up skilling

For no apparent reason 20% indicated that they won't attend any hazardous workshop, while only (30%) indicated that they might attend although they said it will depend on their availability. The remaining 60% agreed that they will attend a hazardous waste workshop if it was to be provided. Having the correct attitude is one of the fundamental keys to a sustainable waste management (Kumar *et al*., 2017). Not being enthusiastic to attend a hazardous workshop shows that some participants have an extremely negative attitude, which they are not willing to change. The Musina Local Municipality would need to work around these concerns, probably by presenting awareness workshops after hours and over a shorter time period (e.g. 1-2 hours).

##### 5.3.2.2.2. Knowledge of recycling and environmental and human health impact

Forty percent of the respondents only had partial knowledge on the concept of recycling, while the other 40% indicated they have adequate knowledge. Only 20% didn't have any knowledge on the concept of recycling. The lack of public knowledge on the environmental effects of waste has been reported as an important barrier to complying with the recommended health behaviour (Zhang et al., 2014). Also, having proper knowledge is one of the most powerful predictors for recycling behaviour among individuals (Babaei *et al*., 2015). Their knowledge on environmental and human health impact was low, thus it is important for participants who work with HW products to know its environmental and human health impacts. This includes human health problems such as skin irritation, cancer and asthma amongst other. The environmental impacts include soil contamination and land pollution.

##### 5.3.2.2.3 Awareness of hazardous waste

Half of the participants were not aware that the waste they discard is hazardous. It is important to fully understand the different type of hazardous waste as well as their impacts on human health and the environment. Only 30% participants regarded recycling of HW as very important. Most of the automotive waste could be recycled thus the study recommends that the Municipality prepares a session with the

respective owners and enlighten them about the different products that could be recycled.

## 5.4 DEVELOP TAILOR-MADE RECOMMENDATIONS FOR THE SAFE MANAGEMENT OF HAZARDOUS WASTE IN THE TOWN OF MUSINA.

There is an existing municipal waste disposal facility within an acceptable transport distance with the potential to be upgraded to the legally required standards The potential volumes of industrial and hazardous waste to be generated is increasing and therefore it is empirical to find ways to manage these types of wastes in order to reduce and manage the negative impacts that they exert on the environment and human health. Below are tailor-made recommendations that policy directives can adopt.

- Currently there are no hazardous waste disposal facilities in the Limpopo province that would be able to accommodate the hazardous waste. The existing facilities that can accommodate hazardous waste are more than 400 km from the site. A study can be conducted to determine the feasibility of constructing hazardous waste facility in the Musina Local Municipality. Recyclables hazardous waste brought to the facility can be exchanged for monitory value. Businesses and industries outside the municipality can bring in their waste for a fee. This will generate revenue for the municipality and create jobs while reducing illegal dumping.
- It is evident that the potential for the reduction, re-use and recycling of waste exists and requires detailed feasibility studies to be undertaken to ensure that the potential benefits from such activities are technically feasible and financially feasible. Waste reduction, reuse, recycling, or recovery must, as per the Waste Management Hierarchy adopted in the National Waste Management Strategy, be prioritised as part of the integrated waste management plans.
- The Integrated Waste Management Plans (IWMP) for Musina Local Municipality must always be updated. With updates to IWMPs required every five years, by law. The latest available IWMP dated 2005. The latest IWMP will reveal the current status quo, and this will assist in making informed decision based on what is currently happening.
- The need for the upgrade and/or expansion of the existing municipal general waste disposal facilities must be investigated further by means of a feasibility

study. This could be the most environmentally sound and financially viable way in which to deal with hazardous waste generated.

- The Municipality should also investigate ways to support the community to manage their waste. The support can be through providing colour coded bins to encourage recycling and conducting awareness campaign. This can be done at school level and throughout the community by various media platform such as Musina radio station, posters as well as social media content.
- According to the 2018/2019 IDP two of the most challenges pertaining to waste management in the Musina Local Municipality are burning of waste and illegal dumping. To combat this the Municipality should strengthen their laws. A heavy fine should be instigated to offenders.

## 5.5 CONCLUSION AND RECOMMENDATION

This study examined the state and management of HW products discarded by various land use zone in the Musina Local Municipality. Hair food and disinfectant containers were amongst the highest hazardous products discarded via municipal landfills. It is important that these products be disposed of in a more environmentally friendly manner due to their harmful effects on human health and the environment. Seeing that there is currently no by-law that guides how hazardous waste discarded by salons should be done, this study recommends that the municipality assess all the salons by having a hazardous management certificate as prerequisite in order to operate beauty salons. Furthermore, the municipality can also look into having hazardous waste facilities were every enterprise can discard in a separate container where it will be dealt with accordingly. In residential areas, the most discarded household products were cleaning products followed by personal care products. None of household separated waste and that is a concern. Some of the waste products that ends up in the landfill site can be exchanged for monetary value which can positively benefits the environment while getting monetary term. The Biggest concern in the Industrial zone is the oil spillage affecting soil and the burning of waste. Burning of waste can cause numerous health dangers including:

- increases risk of heart disease
- aggravates respiratory ailments such as asthma and emphysema

- causes skin rashes, nausea, or headaches
- damages the nervous system
- damages the kidneys and liver
- disrupts the reproductive, endocrinal and development systems

The environmental impacts of burning waste include smog which inhibits plant growth and can cause widespread damage to crop and forests. Vegetation plays a critical role in photosynthesis, a process which absorbs carbon dioxide simultaneously producing the oxygen that we breathe. If we destroy it through excessive pollution, we put ourselves at great risk and promote the accumulation of carbon dioxide in the atmosphere, a major greenhouse gas which drives global warming. Thus, the study recommends that the Musina local municipality categories different enterprises and the type of waste they discard and educate them according to their type of waste they discard.

The study aimed at assessing the state and management of HW discarded by the salons located in the CBD of Musina. To the best of our knowledge this the first study of its kind in South Africa. The limitations of the study lie in the fact that there are only 8 salons located in the CBD of Musina which makes it difficult to run statistical data. Future research can look at including all salons located in the town to form part of the study in order to get more holistic results. The study found that there is a need to manage HW discarded by salons because of the negative public health and environmental impacts they cause. Therefore, it is recommended that a hazardous management certificate be a prerequisite in order to operate a beauty salon due to the number and volume of HW products discarded by these enterprises.

The study aimed at assessing the state and management of HW discarded by household located at the suburbs of Musina. To the best of our knowledge this is the first study of its kind in Musina. Future research can look at a comparative analysis of different suburbs within the same town in order to fully understand where and to which extend is HW discarded excessively. The study found that None of the participant's separate waste. If we want to achieve the zero waste to landfill site target by 2022 it is important that we recycle and treat wastes discarded. Thus, the Study recommends that the local Municipality critically assess barriers hindering the separation at source and implant a plan to promote separation of waste.

Moreover, the study examined the state and management of HW products discarded by automotive workshop located in the Industrial zone of Musina Local Municipality. Although the results could have been more interesting if we had more automotive workshop. It is unfortunate that there are only 10 automotive workshops in the industrial zone of Musina. To the best of our knowledge this is the first study of its kind in Musina. Future research can have a look at a more border geographical area in order to perform statistical analysis between different workshops. The results from this study showed that the discarded HW are recyclable therefore the Musina Local Municipality can look at proving awareness on how best to recycle HW products.

**Summary**

Chapter 5 presents a discussion of the study results, supported by relevant literature. This chapter additionally puts forth a tailor-made recommendation for the safe management of hazardous waste in the town of Musina.

## REFERENCES


Abila, B. and Kantola, J., 2019. The Perceived Role of Financial Incentives in Promoting Waste Recycling—Empirical Evidence from Finland. Recycling, 4(1), p.4.

Acero, J. 2017. Methyl, methacrylate-toxicity, side effects, diseases and environmental impacts. Available at: https://chemicals.news/2017-11-16-methyl-methacrylate-toxicity-side-effects-diseases-and-environmental-impacts.html. Accessed on 20 December 2020.

Adamcova, D., Vaverková, M., Stejskal, B. and Břoušková, E. 2016. Household solid waste composition focusing on hazardous waste. Polish Journal of Environmental Studies 25(2): 487–493.

Adewumi, T. 2015. Analysis of Occupational Exposures of Black Hair Care Professionals in Predominantly Black Salons. MSc. Thesis. University of California, Los Angeles.

Akpan, V. and Olukanni, D. 2020. Hazardous waste management: An African overview. Recycling 5(3): 15.

Alton, L. 2017. How exactly do cleaning supplies affect the environment? Available at: https//www.google.com/amp/s/blueandgreentomorrow.com/environment /how-exactly-cleaning-supplies-affect-environment/amp. Accessed on 18 February 2020.

Alumur, S. and Kara, B. 2007. A new model for the hazardous waste location-routing problem. Computers & Operations Research 34(5): 1406–1423.

Amasa, W., Santiago, D., Mekonen, S. and Ambelu, A. 2012. Are cosmetics used in developing countries safe? Use and dermal irritation of body care products in Jimma Town, Southwestern Ethiopia. Journal of Toxicology 2012: 1–8.

Arif, A. and Delclos, G. 2011. Association between cleaning-related chemicals and work-related asthma and asthma symptoms among healthcare professionals. Occupational and Environmental Medicine 69(1): 35-40.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological profile for lead. Available at: https:www.atsdr.cdc.gov/Toxprofiles/tp13.pdf. Accessed on 08 February 2020.

Awuchi, C.G and Igwe, S.V. 2017. Industrial waste management: Brief survey and advice to cottage, small and medium scale industries in Uganda. International Journal of Advanced Academic Research 3 (1): 26-43.

Babaei, A.A., Alavi, N., Goudarzi, G., Teymouri, P., Ahmadi, K. and Rafiee, M. 2015. Household recycling knowledge, attitudes and practices towards solid waste management. Resource Conservation Recycling. 102: 94–100.

Babazadeh, T., Nadrian, H., Mosaferi, M. and Allahverdipour, H. 2018. Identifying challenges and barriers to participating in the source separation of waste program in Tabriz, Northwest of Iran: A qualitative study from citizens' perspective. Resource 7(3): 53.

Bachand, A.M., Mundt, K.A., Mundy, D.J. and Montgomery, R.R. 2010. Epidemiological studies of formaldehyde exposure and risk of leukaemia and nasopharyngeal cancer: A meta-analysis. Critical Reviews in Toxicology 40: 85–100.

Banerejee, S., Aditya, G. and Saha, G. 2013. Household disposables as breeding habitats of dengue vectors: Linking wastes and public health. Waste Management 33(1): 233–239.

Barnes, D.K.A., Galgani, F., Thompson, R.C. and Barlaz, M. 2009. Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of the Royal Society B: Biological Sciences B 364(1526): 1985–1998.

Bello, A., Quinin, M., Perry, M. and Milton, D. 2010. Quantitative assessment of airborne exposures generated during common cleaning tasks: A pilot study. Environmental Health 9(1):76.

Bigambo, F.M. 2017. Occupational health hazard and illnesses awareness among hairdresser and nail salon worker's: A case of Kinondoni Municipality, Dar es Salaam, Tanzania. PhD Thesis. The Open University of Tanzania, Dar es Salaam.

Blundell, T. 2003. Chemicals in Products: Safeguarding the Environment and Human Health. Royal Commission on Environmental Pollution. 24th Report, London, UK.

Boonrod, K., Towprayoon, S., Bonnet, S. and Tripetchkul, S. 2015. Enhancing organic waste separation at the source behavior: A case study of the application of motivation mechanisms in communities in Thailand. Resource Conservation and Recycling 95: 77–90.

Bortoleto, A., Kurisu, K. and Hanaki, K. 2012. Model development for household waste prevention behaviour. Waste Management 32(12): 2195–2207

Cameron, R. 2010. Mixed Methods in VET Research: Usage and Quality. International Journal of Training Research, 8(1): 25-39.

Cao, X., Ji, L., Lin, X., Stevens, W., Tang, M., Shang, F., Tang, S. and Lu, S. 2018. Comprehensive diagnosis of PCDD/F emission from three hazardous waste incinerators. Royal Society Open Science 5(7): 172056.

Chang, N. and Davila, E. 2008. Municipal solid waste characterizations and management strategies for the Lower Rio Grande Valley, Texas. Waste Management 28(5): 776–794.

Cheng, Y., Schwartz, J., Sparrow, D., Aro, A., Weiss, S. and Hu, H. 2001. bone lead and blood lead levels in relation to baseline blood pressure and the prospective development of hypertension the normative aging study. American Journal of Epidemiology 153(2): 164–171.

Choong, T., Chuah, T.G., Robia, Y., Koay, F.G. and Azni, I. 2007. Arsenic toxicity, health hazardous and removal techniques from water: An overview. Desalination 217(1-3): 139–166.

Chu, Z., Xi, B., Song, Y. and Crampton, E. 2013. Taking out the trash: Household preferences over municipal solid waste collection in Harbin, China. Habitat Int. 40, 194–200.

Crabtree, D. 2016. Solid Waste Facility. South Africa, pp.3

Dangi, M.B., Pretz, C.R., Urynowicz, M.A., Gerow, K.G. and Reddy, J.M. 2011. Municipal solid waste generation in Kathmandu, Nepal. Journal of Environmental Management 92: 240–249.

Department of Environmental Affairs (DEA). 2012. Chapter 9: Waste Management, draft 2 version 3. South Africa Environmental Outlook. A report on the State of Environment. Department of Environmental Affairs. Pretoria.

Department of Environmental Affairs and Tourism (DEAT). 2000. Guideline on recycling of solid waste: Resource recovery. Available at: http://www.resource-recovery.net

Department of Environmental Affairs. 2012. National waste information baseline report. Available at: https://www.sawic.environment.gov.za/documents. Accessed on 15 February 2020.

Dikson, K. 2019. Cosmetic: A beautiful waste. Available at: https://Resources.co/article/cosmetics-beautiful-waste-13018. Accessed on 19 September 2020.

Dotoli, M. and Epicoco, N., 2017. A vehicle routing technique for hazardous waste collection. IFAC-PapersOnLine 50 (1): 9694–9699.

Edokpayi, J.N., Odiyo, J.O., Durowoju, O.S. and Adetoro, A. 2017. Household Hazardous Waste Management in Sub Saharan Africa. Household Hazardous Waste Management (2017): 61.

Elbeshbishy, E. and Okoye, F. 2019. Improper disposal of household hazardous waste: Landfill/Municipal wastewater treatment plant. Municipal Solid Waste Management. IntechOpen.

Ellis, M. 2019. How to properly dispose of common nail products. Available at: https://www.nailsmag.com/604172/how-to-properly-dispose-of-common-nail-products. Accessed on 05 March 2020.

Environmental Protection Agency (EPA). 2014. The Resource Conservation and Recovery Act (RCRA) Orientation Manual. 1200 Pennsylvania Avenue, N.W. WASHINGTON, DC 20460.

Espinoza, R. 2018. How hazardous waste disposal affects. Available at: https://www.Google.com/amp/s/blog.Idrenvironmental.com/how-hazardous-waste-disposal-affects–the-environment. Accessed on 10 August 2020.

Essence. 2019. Naturally curly. Available at: https://www.essence.com. Accessed on September 2019.

World Health Organization. 2000. Ethylene glycol: Environmental aspects. WHO, Geneva

Fazzo, L., Minichilli, F., Santoro, M., Ceccarini, A., Della Seta, M., Bianchi, F., Comba, P. and Martuzzi, M. 2017. Hazardous waste and health impact: A systematic review of the scientific literature. Environmental Health 16(1): 1–11.

Felzenswalb, I., Fernandes, A., Brito, L., Oliveira, G., Silva, P., Arcanjo, M., Marques, M., Vicari, T., Leme, D., Cestari, M. and Ferraz, E. 2018. Toxicological evaluation of nail polish waste discarded in the environment. Environmental Science and Pollution Research 2018: 1–14.

Fierens, T., Servaes, K., Van Holderbeke, M., Geerts, L., De Henauw, S., Sioen, I. and Vanermen, G. 2012. Analysis of phthalates in food products and packaging materials sold on the Belgian market. Food and Chemical Toxicology 50(7): 2575–2583.

Folk, E. 2018. Environment common beauty industry environmental issues. Available at: https://conservationfolks.com/common-beauty-industry-environmental-issues. Accessed 15 August 2020.

Gao, D. and Wen, Z. 2016. Phthalate esters in the environment: A critical review of their occurrence, biodegradation, and removal during wastewater treatment processes. Science of the Total Environment 541: 986–1001.

Geffen, C. and Rotheberg, S. 2000. Suppliers and environmental innovation. International Journal of Operations and Production Management 20(2): 166–186

Geyer, R., Jambeck, J.R. and Law, K.L. 2017. Production, use and fate of all plastics ever made. Science Advances 3: e1700782.

Giacovelli, C. 2018. Single-use plastics: A roadmap for sustainability. Available at: http://wedocs.unep.org. Accessed 12 January 2021.

Glanz, K., Rimer, B.K. and Viswanath, K. 2008. Health Behavior and Health Education: Theory, Research, and Practice. John Wiley and Sons: Hoboken, NJ, USA.

Grynkiewicz-Bylina, B. 2011. Dangerous phthalates in children’s environment. Ecological Chemistry and Engineering S. 18(4): 455–463.

Gu, B., Zhu, W., Wang, H., Zhang, R., Liu, M., Chen, Y., Wu, Y., Yang, X., He, S., Cheng, R., Yang, J. and Bi, J. 2014. Household hazardous waste quantification, characterization and management in China’s cities: A case study of Suzhou. Waste Management, 34(11): 2414–2423.

Hasan, S. 2004. Public awareness is the key to successful waste management. Journal of Environmental Science and Health Part A 39(2): 483–492.

Hassan, C., Ali, H. and Muawia, M.A. 2014. Household hazardous waste management in Malaysia. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering 3(12): 32–50.

Hassandvand, M., Naddafi, K., Nabizedah, R., Momeniah, F., Mesdaghinia, A. and Yaghmaiean, K. 2011. Hazardous waste management in educational and research centers: A case study. Toxicological and Environmental Chemistry, 93(8): 1636–1642.

Handayani, D., Gitaharie, B., Yussac, R. and Rahmanie, R., 2018. How does household characteristics influence their waste management? E3S web of Conferences, 74, pp.06005

Heale, R. and Twycross, A. 2015. Validity and Reliability in Quantitative Studies. Evidence Based Nursing, 18(3): 66-67.

Hopewell, J., Dvorak, R. and Kosior, E. 2009. Plastic recycling: Challenges and opportunity. Philosophical Transactions of the Royal Society B; Biological Sciences 364(1526): 2115–2126.

https://chemtrust.org/hazardouschemicals-plastic-list/ [Accessed 21 Oct. 2019]

https:www.onegreenplanet.org/environmental/toxins-lurking-in-nail-polish-harmful-to your- health- and-planet/ [Accessed 16 April 2020].

https;//www.yourglovessource.com/blogs/gloveknowledgebase/why-you-use-glovesin-the salon [Accessed 18 Sept. 2019]

Independent Expert Advisory Group. 2014. A World That Counts. Mobilizing the data revolution for sustainable development. The United Nations, New York.

Inglezakis, V.J. and Moustakas, K. 2015. Household hazardous waste management: A review. Journal of Environmental Management 150: 310–321.

Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayn, R and Law, K.L. 2015. Plastic waste inputs from land into ocean. Science 347(6223): 768–771.

Jambeck, J., Hardesty, B.D., Brooks, A.L., Friend, T., Teleki, K., Fabres, J., Beaudoin, Y, Bamba, A., Francis, J., Ribbink, A.J. and Baleta, T. 2018. Challenges and emerging solutions to the land-based plastic waste issue in Africa. Marine Policy 96: 256–263.

Jonsson, S., Ejlertsson, J. and Svensson, B.H. 2003. Transformation of phthalates in young landfill cells. Waste Management 23: 641–651.

Joshua, A.I., Mohammed, S., Makama, J.G., Joshua, W.I., Audu, O. and Nmadu, A.G. 2014. Hospital waste management as a potential hazard in selected primary healthcare centres in Zaria Nigeria. Nigerian Journal of Technology 33(2): 215–221.

Juliano, C. and Magrini G., 2017. Cosmetic ingredients as emerging pollutants of environmental and health concern. A mini-review. Cosmetic 4(2): 11.

Jyotie, S., 2015. Health issues and environmental impact of cleaning agents. International Journal of Novel Research in Life Sciences 2(2): 31–38.

Katheem, K., Ibrahim, M., Quaik, S. and Isamail, S. 2015. Prospects of Organic Waste Management and Significance of Earth Warm: Springer International Publisher, Malaysia.

Klinch, B.A. and Stuart, M.E. 1999. Human health risk in relation to landfill leachate quality. British Geological Survey, Technical Report; Overseas Series; Key Worth, Notteningham NG125CC; United Kingdom.

Kumar, B. 2017. Oil and lubricant hazardous effects on human health. International Journal of innovative Science, Engineering and Technology 4: 315–322.

Kumar, S., Smith, S., Fowler, G., Velis, C., Kumar, S., Arya, S., Kumar, R. and Cheeseman, C. 2017. Challenges and opportunities associated with waste management in India. Royal Society Open Science 4(3): 160764.

Labour Department. 2007. Chemical Safety in a Work Place-Guidance: Notes on Safe Use of Chemical Disinfectants. 1st edition. HKSAR Government, Hong Kong.

Lah, K. 2011. Effects of pesticides on human health. In Toxipedia. Available at: http://www.toxipedia.org/display/toxipedia/effects+of+Pesticides+on+Human+Health. Accessed 15 March 2020.

Landrigan, P.J., Wright, R.O., Cordero, J.F., Eaton, D.L., Goldstein, B.D., Hennig, B. et al. 2015. The NIEH Superfund Research Program: 25 years of translational research for public health. Environmental Health Perspective 123: 909–918.

Lee, S., Nam, B., Harrison, R. and Hong, O. 2014. Acute symptoms associated with chemical exposures and safe work practices among hospital and campus cleaning workers: A pilot study. American Journal of Industrial Medicine 57(11): 1216–1226.

Li, L., Wang, S., Lin, Y., Liu, W. and Chi, T. 2015. A covering model application on Chinese industrial hazardous waste management based on integer program method. Ecological Indicators 51: 237–243.

Licy, D., Raghavan, V., Josphina, C. 2013. Awareness, attitude and practice of school students towards household waste management. Journal of Environment 2: 147–150

Limpopo Economic Development Strategy (LED Strategy). 2007. Musina Local Municipality (South Africa). Available at: https://www.musina.gov.za/official-documents/led. Accessed 06 March 2020.

Lim-Wavde, K., Kauffman, R. and Dawson, G. 2016. Policy analytics, household informedness and the collection of household hazardous waste. MATEC Web of Conferences 68:14003.

Lim-Wavde, K., Kauffman, R., Kam, T. and Dawson, G. 2019. Do grant funding and pro-environmental spillovers influence household hazardous waste collection? Applied Geography 109: 102032.

Luyt, A. and Malik, S. 2019. Can biodegradable plastics solve plastic solid waste accumulation? Plastics to Energy 2019: 403–423.

Mahmood, I., Imandi, S., Shazandi, K., Gul, A. and Hakeem, K. 2016. Effects of pesticides on environment. Plant, Soil and Microbes 2016: 253–269.

Makgae, M. 2011. Key areas in waste management. A South African perspective. Integrated Waste Management. Volume 2. Kumar, S. (Ed). IntecOpen Ltd. UK.

MARCH, B. 2018. Beauty and the environment: Eco-friendly choices made easier. Available at: https://www.harpersbazaar.com/uk/beauty/a19848167/beauty-environmental-impact-sustainability. Accessed 14 May 2020.

Marsili, D., Fazzo, L. and Comba, P. 2009. Health risks from hazardous waste disposal: The need for international scientific cooperation. European Journal of Oncology 14: 151–159.

Martinez-Pena, R., Hoogesteijn, A., Rothenberg, S., Cervera-Montejano, M. and Pacheco-Avila, J. 2013. Cleaning products, environmental awareness and risk perception in Merida, Mexico. PLos ONE 8(8): e74352.

Marwa, C. 2000. Management of solid waste from the dry cell factory - Case study of Matsushita Electric Company (EA) Ltd. Unpublished report. Department of Environmental Engineering, University College of Lands and Architectural Studies (UCLAS). Dar es Salaam, Tanzania.

Matter, A., Dietschi, M. and Zurbrügg, C. 2013. Improving the informal recycling sector through segregation of waste in the household –The case of Dhaka Bangladesh. Habitat International 38: 150–156.

McCormack, V. and Schüz, J. 2012. Africa's growing cancer burden: Environmental and occupational contributions. Cancer Epidemiology 36(1): 1–7.

Medina, M. 2002. Globalisation, development and municipal solid waste management in third world cities. Available at: https://www.slideshare.net. Accessed 20 September 2020.

Mishra, V., Sharma, U., Rawat, D., Benson, D., Singh, M. and Sharma, R. 2020. Fast-changing lifestyles and ecotoxicity of hair dyes drive the emergence of hidden toxicants threatening environmental sustainability in Asia. Environmental Research 184: 109253.

Misra, V. and Pandey, S.D. 2004. Hazardous waste, impact on health and environment for development of better waste management strategies in future in India. Environment International 31(3): 417–431.

Mmereki, D., Baldwin, A., Hong, L. and Li, B. 2016. The management of hazardous waste in developing countries. Management of Hazardous Wastes 2016: 39.

Mmereki, D., Li, B., Hong, L. and Baldwin, A. 2017. Introductory chapter: Overview of household hazardous waste management in the African context. Household Hazardous Waste Management (2017): 1.

Mmereki, D., Baldwin, A., Homg, L. and Li, B. 2016. The management of hazardous waste in developing countries. Management of Hazardous Wastse (2016): 39.

Mucina Local Municipality. 2018. About Musina Municipality. Available at: https://www.musina.gov.za/about. Accessed 22 January 2021.

Murphy, R.E. 2007. The Central Business District - A Study in Urban Geography. Routledge, New York.

Murray, R. 1999. Creating Wealth from Waste. Demos, London, UK.

Mwanza, B., Mbohwa, C. and Telukdarie, A., 2018. Levers Inluencing Sustainable Waste Recovery at Households Level: A review. Procedia manufacturing, 21, pp.615-622

Nahman, A. and Godfrey, L. 2010. Economic Instrument for solid waste management in South Africa: Opportunity and constrains. Resource, Conservation and Recycling 8: 521–531.

National Household Hazardous Waste Forum (NHHWF). 2008. Occupational Health and Safety Information Service. Available at: https://products.ihs.com/Ohsis-SEO/NATIONAL. Accessed 10 January 2021.

Navia, R. and Bezama A. 2008. Hazardous waste management in Chilean Main Industry: An overview. Journal of Hazardous Material 158(1): 177–184.

News24. 2019. Used oil: Dangerous water contaminant that needs to be kept out of the environment. Available at: https://www.news24.com/amp/news24. Accessed 15 April 2020.

Nnedinma, N.N. 2010. Analysis of the management of household hazardous waste in Enugu Metropolis. Unpublished M.Sc. Thesis, University of Nigeria, Nsukka.

Nowak, P., Kucharska, K. and Kamminski, M. 2019. Ecological and health effects of lubricant oils emitted into the environment. International Journal of the Environmental Research and Public Health 16(16): 3002.

Nwachukwu, M., Feng, H. and Achilikie, K. 2010. Integrated studies for automobile waste management in developing countries; in the concept of environmentally friendly mechanic village. Environmental Monitoring and Assessment 178(1-4): 581–593.

Nweke, O. and Sanders III, W. 2009. Modern Environmental Health Hazardous: A public health Issue of increasing significance in Africa. Environmental Health Perspective 117(6): 836–837.

Odufuwa, B.A., Odufuwa, B.O., Ediale, O.M. and Oriola, S. 2012. Household participation in waste disposal and management in Ijebu-Ode, Nigeria. Journal of Human Ecology 40(3): 247–254.

Odukoya, O.V., Arowolo, T. and Bamgbose, O. 2002. Effects of solid waste landfill on underground and surface water quality at ring road, Ibadan, Nigeria. Global Journal of Environmental Sciences 1(1): 43–52.

General, A. 2010. Value for money audit report on solid waste management in Kampala. Unpublished report of the Republic of Uganda.

Ogola, J.S., Chimuka, L. and Tshivhase, S. 2011. Management of municipal solid wastes: A case study in Limpopo Province, South Africa. In: Integrated Waste Management. Volume I. IntechOpen.

Ojeda-Benitez, S., Cruz-Sotelo, S., Velazquez, L., Santillan-Soto, N., Nunez, M., Cueto, O. and Markus, W. 2013. Electrical and electronic waste in northwest Mexico. Journal of Environmental Protection 04(05): 405–410.

Olukunle, O.L and Okonkwo, O.J. 2015. Concentration of novel brominated flame retardants and HBCD in leachates and sediments from selected municipality solid waste landfill sites in Gauteng Province South Africa. Waste Management 43: 300–306.

Omokhodion, F.O., Balogun, M.O. and Ola-Olorun, F.M. 2009. Reported occupational hazards and illnesses among hairdressers in Ibadan, Southwest Nigeria. West African Journal of Medicine 28(1): 310–313.

Öncel, M.S., Bektaş, N., Bayar, S., Engin, G., Çalişkan, Y., Salar, L. and Yetiş, Ü. 2017. Hazardous wastes and waste generation favours for plastic products manufacturing industries in Turkey. Sustainable Environmental Research 27(4): 188–194.

Otoniel, B., Liliana, M. and Francelia, P. 2008. Consumption patterns and household hazardous solid waste generation in an urban settlement in Mexico. Waste Management 28: S2–S6.

Ottman, J. 2000. Green Marketing Opportunity for Innovation. 2nd Edition NTC Business Books, Chicago.

Panyako, O.O., Wakhuhgu, J.W. and Kioli, F.N. 2015. Demographic and socioeconomic factors as determinates of environmental attitude in Mavoko peri-urban settlements of Nairobi Metropolis, Kenya. Asian Journal of Social Sciences and Humanities 3(3): 20–43.

Paul, R. 2009. End-of-life-management of waste automotive material and efforts to improve sustainability in North America. WIT Transaction on Ecology and the Environment 120: 853–861.

Periathamby, A. 2001. Solid waste: Principles and management. University of Malaya, Kuala Lumpur.

Plant, J.S., David, S., Barry, F. and Lorraine, W. 2001. Environmental geochemistry at the global scale. Journal of Applied Geochemistry 16(11-12): 1291–1308.

Porwal, T. 2015. Paint pollution harmful effects on environment. International Journal of Research 3: 104.

Predolich, M. 2017. Why you should use gloves in the salon. Available at https://www.yourglovesource.com/blogs/glove-knowledgebase/tagged/safety-work-gloves?page=2. Accessed 21 January 2021.

Przybylinska, P. and Wyszkowski, M. 2016. Environmental contamination with phthalates and its impact on living organisms. Ecological Chemistry and Engineering S 23(2): 347–356.

Pumfrey, H. 2018. Earth Day 2018: The environmental impact of the cosmetic industry. Available at: https://www.google.com/amp/s/www.floraandcesta.com/flor-and-cesta/earth-day-2018-the-environmental-impact-of-the-cosmetics-industry. Accessed 05 March 2020.

Putoisis, A. 2015. The ugly truth: Toxins lurking in nail polish are harmful to your health and the planet. One green planet. Available at: https://www.onegreenplanet.org/environment/toxins-lurking-in-nail-polish-are-harmful-to-your-health-and-the-planet. Accessed 21 January 2021.

Quinn, M.M., Henneberger, P., Braun, B., Delclos, G., Fagan, K., Huang, V., Knaack, J., Kusek, L., Lee, S., Le Moual, N., Maher, K., McCrone, S., Mitchell, A., Pechter, Rabbani, M., Heidari, R. and Yazdanparast, R. 2019. A stochastic multi-period

industrial hazardous waste location-routing problem: Integrating NSGA-II and Monte Carlo simulation. European Journal of Operational Research 272(3): 945–961.

Quinn, M.M., Henneberger, P.K., Braun, B., Delclos, G.L., Fagan, K., Huang, V., Knaack, J.L., Kusek, L., Lee, S.J., Le Moual, N. and Maher, K.A. 2015. Cleaning and disinfecting environmental surfaces in health care: Toward an integrated framework for infection and occupational illness prevention. American Journal of Infection Control 43(5): 424-434.

Rajput, N., Shah, C., Bhadauriya, M., Gajabe, P. and Umatiya, M. 2019. Global and Indian E-Waste Management - Methods, Challenges & Impacts. 2321-9653.

Roche, D. 2015. Landfill failure survey: A technical note. Geological Society, London, Engineering Geology Special Publications 11(1): 379–380.

Rosefoundation.org.za. 2020. SA's automotive workshops legally and morally required to manage used oil responsible. Available at: http://rosefoundation.org.za. Accessed 15 June 2020.

Rousta, K., Ordonez, I., Bolton, K. and Dahlen, L. 2017. Support for designing waste sorting system: A mini-review. Waste management and Research 35(11): 109–111.

Salihoglu, G. and Salihoglu, N. 2016. A review on paint sludge from automotive industries: Generation, characteristics and management. Journal of Environmental Management 169: 223–235.

Samanlioglu, F. 2013. A multi-objective mathematical model for the industrial hazardous waste location-routing problem. European Journal of Operational Research 226(2): 332–340.

Sankhla, M., Kumari, M., Nandan, M., Mohril, S., Signh, G., Chaturvedi, B. and Kumar D. 2016. Effect of electronic waste on environmental management and human health - A review. IOSR journal of Environmental Science, Toxicology and Food Technology 10(09): 98–104.

Secheel, W. 2019. How to manage hazardous waste in your salon. Available at: https:Salontday.com/603709/how-to-manage-hazardous-in-your-salon. Accessed 05 March 2020.

Sharma, P., Sharma, A., Sharma, A and Srivastava, P. 2016. Automobile waste and its management. Research Journal of Chemical and Environmental Sciences 4(2): 1–7.

Sidique, S., Joshi, S. and Lupi, F., 2010. Factors influencing the rate of recycling: An analysis of Minnesota countries. Resources, Conservation and Recycling, 54(4), pp.242-249

Singh, J., Saxena, R., Bharti, V. and Singh, A. 2018. The importance of waste management to environmental sanitation: A review. Advances in Bioresearch 9(2): 202–207.

Slack, R., Gronow, J. and Voulvoulis, N. 2005. Household hazardous waste in municipal landfills: Contaminants in leachate. Science of The Total Environment 337(1-3): 119–137.

Slagsted, H. and Bratebo, H. 2012. LCA for household waste management when planning a new urban settlement. Waste Management 32(7): 1428–1490.

Statistics South Africa (StatsSA). 2011. South African Statistics. Statistics South Africa. Pretoria.

Teranzono, A., Oguchi, M., Lino, S. and Mogi, S. 2015. Battery collection in municipality waste management in Japan: Challenges of hazardous substance control and safety. Waste Management 39: 246–257.

Thanh, N., Matsui, Y. and Fujiwara, T. 2010. Household solid waste generation and characteristic in a Mekong Delta city, Vietnam. Journal of Environmental Management 91(11): 2307–2321.

The Australian Government. 2019. Why we should recycle used motor oil. Available at: https://www.canberra:environment.gov.au. Accessed 24 April 2020.

Thompson, R.C., Moore, C.J., Vom Saal, F.S. and Swan, S.H. 2009. Plastic, the environment and human health: Current consensus and future trends. Philosophical Transactions of the Royal Society B: Biological Sciences 364(1526): 2153–2166.

Trivedi, A., Singh, A. and Chauhan, A. 2015. Analysis of key factors for waste management in humanitarian response: An interpretive structural modelling approach. International Journal of Disaster Risk Reduction 14: 527–535.

Turpie, J., Letely, G., Ng'oma, Y. and Moore, K. 2019. The case for banning single use plastics in Malawi. Report prepared for UNDP on behalf of the Government of Malawi by Anchor Environmental Consultants in collaboration with Lilongwe Wildlife Trust. Anchor Environmental Consultants Report No. AEC/1836/1. 72pp.

U.S. Environmental Protection Agency. 2016. Evaluation of the Inhalation Carcinogenicity of Ethylene Oxide (CASRN 75-21-8) In Support of Summary Information on the Integrated Risk Information System (IRIS). National Center for Environmental Assessment Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC

U.S. EPA. 2015. Getting up to speed: Ground water contamination. In: Chapter 3, Wellhead Protection: A Guide for Small Communities, EPA/625/R-93/002, Seminar Publication. Washington.

Ubachukwu, N.N. 2010. Analysis of the management of household hazardous waste in Enugu Metropolis. Doctoral Thesis. University of Nigeria, Nsukka.

UKEssays. 2018. Impacts of cosmetic Waste. Available at: https://www.ukessays.com/essays/environmental-studies/impacts-of-cosmetic-waste.php?vref=1. Accessed 5 March 2020.

Ulinskaite, J., Staniškis, J.K. and Motiejūnas, J. 2006. Analysis and improvement possibilities of hazardous waste management system in Lithuania. Environmental Research, Engineering and Management 4: 40–50.

United Nation Statistics Division (UNSD). 2006. Statistics division at a glance. Department of Economic and Social Affairs. United Nations. http://unstats.un.org. Accessed 12 March 2020.

Bernstein, J.A., Alexis, N., Barnes, C., Bernstein, I.L., Nel, A., Peden, D., Diaz-Sanchez, D., Tarlo, S.M. and Williams, P.B. 2004. Health effects of air pollution. Journal of Allergy and Clinical Immunology 114(5): 1116-1123.

Vrijheid, M. 2000. Health effects of residence near hazardous waste landfill sites: A review of epidemiologic literature. Environmental Health Perspective 108(Suppl. 1): 101–112.

Wassenaar, A. 2017. Is your salon helping, or harming the environment? Available at: https://www.gettimely.com/blog/salon-helpingharming environment. Accessed 20 September 2019.

Watson, A. 2018. Hazardous chemicals and plastic packaging: What are the concerns? Available at: https://chemtrust.org/hazardous-chemicals-plastic-list. Accessed 15 January 2021.

White, H., Khan, K., Lau, C., Leung, H., Montgomery, D. and Rohlman, D. 2015. Identifying health and safety concerns in Southeast Asian immigrant nail salon workers. Archives of Environmental and Occupational Health 70(4): 196–203.

World Health Organization (WHO). 2017. Recycling used lead-acid batteries: Health considerations. Available at: https://www.who.int/ipcs/publications/u/lab/en/ Accessed 18 February 2021.

Yilmaz, O., Kara, B. and Yetis, U. 2017. Hazardous waste management system design under population and environmental impact considerations. Journal of Environmental Management 203: 720–731.

Yukalang, N., Clarke, B. and Ross, K. 2018. Solid waste management solutions for a rapidly urbanizing area in Thailand: Recommendations based on stakeholder input. International Journal of Environmental Research and Public Health 15(7): 1302.

Zhang, H.W. and Wen, Z.-G. 2014. Residents' household solid waste (HSW) source separation activity: A case study of Suzhou, China. Sustainability 6: 6446–6466.

Zhang, J., Chen, C., Zhang, X. and Liu, S. 2016. Study on the environment risk assessment of lead-acid batteries. Procedia Environmental Sciences 31: 873-879.

Zhu, M.H., Fan, X.M., Rovetta, A., He, Q., Vicentini, F., Liu, B.K., Giusti, A., Liu, Y. 2009. Municipal solid waste management in Pudong New Area, China. Waste Management 29(3): 1227–1233.

**ADDENDUM A**

**Survey of hazardous waste generated and management by inhabitants of the Musina Local Municipality in Limpopo Province, South Africa**

Questionnaire number……..

Zone…….

This questionnaire aims at surveying hazardous waste generated and management by inhabitants of the Musina Local Municipality in Limpopo Province, South Africa.

The aim of this study is to compare the state of hazardous waste generation and management in the Musina Local Municipality, and perception and awareness of its inhabitants, with the aim of developing an adoptive management for the various land use zones. In this survey, I asked several questions regarding the management of Hazardous Waste (HW). Information gathered through this questionnaire will be solely for research purposes. Your responses will be kept confidential. No identities are sought through this questionnaire; therefore, your identity will be kept anonymous. Feel free to express yourself responding to this questionnaire.

**SECTION A: DEMOGRAPHIC CHARACTERISTICS**

1. Gender

| | | | | | |
|---|---|---|---|---|---|
| 1 | Male | | 2 | Female | |

2. Age

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | <18 | | 2 | 19-35 | | 3 | 36-59 | | 4 | .>60 | |

3. Do you have any formal education?

| | | | | | |
|---|---|---|---|---|---|
| 1 | Yes | | 2 | No | |

4. If yes, what's your highest level of education Level of education?

| | | |
|---|---|---|
| 1 | Primary | |
| 2 | High School | |
| 3 | Certificate | |
| 4 | Diploma | |
| 5 | Degree | |
| 6 | Honours | |
| 7 | Masters | |
| 8 | PhD | |
| 9 | Other | |

5. Size of household (In industries and shops then number of labours)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 5 | 6 | 6 | 7 | 7 | 8 | >7 |

**SECTION B: TYPES AND QUANTITY OF HAZARDOUS WASTE**

6. Which of the following products do you mostly use?

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | Motor oil | | 6 | Paraffin | | 11 | Electronic devices | |
| 2 | Pool chemicals | | 7 | Disinfectants | | 12 | Old light bulb | |
| 3 | Paint | | 8 | Paper | | 13 | Herbicides/insecticides | |
| 4 | Car batteries | | 9 | Plastic | | 14 | Glass | |
| 5 | Tyres | | 10 | Hair spray/Shampoos | | 15 | Inks | |

7. Have you ever used other products other than other than ones you have provided? Explain

……

8. How much of the waste do you generate per week, based on the selected products?

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | 2 | 2 | | 3 | 3 | | 4 | 4 | | 5 | 5 | | 6 | 6 | | 7 | 7 | | 8 | >7 | |

**SECTION C: DISPOSAL METHODS**

9. Which of the following methods do you use to temporary store the hazardous waste produced by the products you use? Tick the appropriate answer(s)

| | | | | | |
|---|---|---|---|---|---|
| 1 | Sealed containers | | 2 | Roll-off (dumpster) | |
| 3 | Curbside dustbins | | 4 | Large drums | |
| 5 | Municipal Refusal bags | | 6 | Waste piles | |

10. If not the above methods which ways do you temporarily store your waste

……

11. Do you separate the waste that you produce?

| | | | | | |
|---|---|---|---|---|---|
| 1 | Yes | | 2 | No | |

If yes how? If no, why?

……
……
……
……..

12. After temporary storage, how do you dispose the waste hazardous waste produced by the products?

| | | | | | |
|---|---|---|---|---|---|
| 1 | Dumping site | | 2 | Composting | |
| 3 | Recycle | | 4 | Throw in an open area/(road side) | |
| 5 | Burning | | 6 | Gridding and discharging into sewers | |

13. If not the above methods which ways do you temporarily store your waste.

……

**SECTION D: PERCEPTION AND AWARENESS**

14. Are you aware that you products are hazardous?

| | | | | | |
|---|---|---|---|---|---|
| 1 | Yes | | 2 | No | |

Explain

……
……
……
……

15. Do you know how the products should be sustainably managed?

| | | | | | |
|---|---|---|---|---|---|
| 1 | Yes | | 2 | No | |

16. Explain

……
……
……
……

17. Explain the factors behind your methods of managing hazardous waste?

……
……

……
……

18. Given support would you improve on the way you handling waste?

| | | | | | |
|---|---|---|---|---|---|
| 1 | Yes | | 2 | No | |

19. Explain

……
……
……
……

20. How much knowledge would you say you have on the concept of recycling?

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | Partial | | 2 | None at all | | 3 | Enough | |

21. Do you know of any environmental and human health impacts that can be caused by hazardous waste? If yes, please mention them

| | | | | | |
|---|---|---|---|---|---|
| 1 | Yes | | 2 | No | |

……
……
……
……

22. Would you attend a hazardous waste workshop if it was to be done?

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Yes | | 2 | Maybe | | 3 | No |

23. How often does your waste stay in your home before it gets disposed of?

| | | | | | |
|---|---|---|---|---|---|
| 1 | Day | | 2 | Two weeks | |
| 3 | 3 days | | 4 | Monthly | |
| 5 | A week | | 6 | Quarterly | |

24. What is your opinion on effective handling of hazardous waste in the area?

……

……

……..

**THANK YOU FOR PARTICIPATING IN THIS SURVEY**

**ADDENDUM B**

**LETTER OF DATA COLLECTION**

**University of Limpopo**

**Private Bag X1106, Sovenga, 0727, South Africa**

**Tel: (015) 268 2224, 083 399 1787 Email: Martin.potgieter@ul.ac.za**

Dear participants,

Please note that Happy Andani Nematshavhawe is a Masters student (in Geography) at the University of Limpopo, Limpopo Province. To complete his studies, he is expected to conduct a research study and cite a report on his findings.

Management of hazardous waste is one of the major environmental issues, therefore his study seeks to assess how hazardous waste is discarded by different land use zone in the Musina Local Municipality in order to reduce and manage the negative impacts that they exert to the environment and human health. Questionnaire will be administered at

CBD, (salons),

Bergview Ex4 and ex8

and Industrial node found at extension 3 and Blikkiesdorp

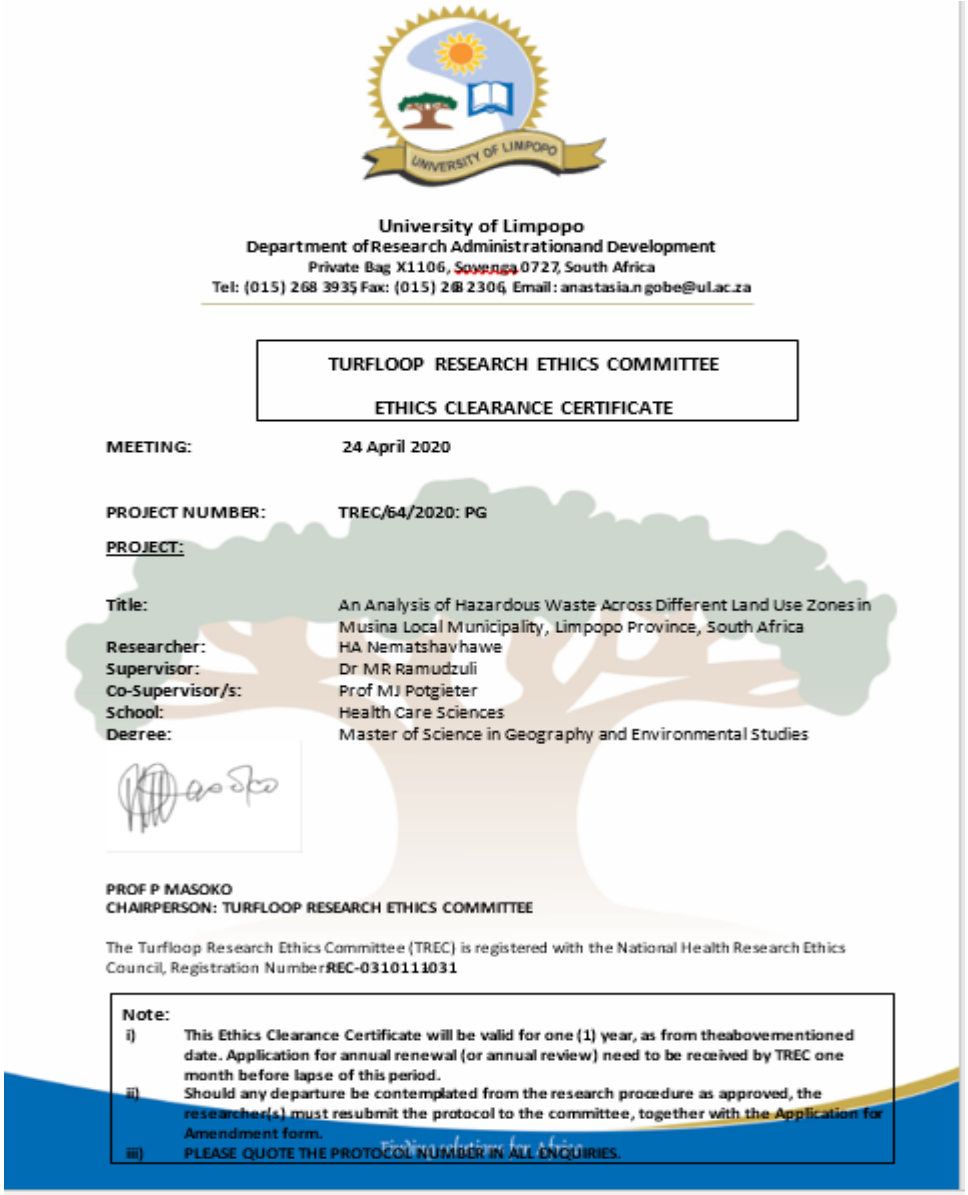
Please note that participation in this study is entirely voluntary and interviewees can refuse to participate or stop at any time without prejudice. Participants can also withdraw their consent at any time, before, during or at the end of the interview. Most important, please note that the results of this study will be processed in to a report but will not include any information that identify participants, which will remain anonymous.

Regards

**Prof MJ Potgieter**

Co-supervisor

## ADDENDUM C



University of Limpopo
Department of Research Administrationand Development
Private Bag X1106, Sovenga 0727, South Africa
Tel: (015) 268 3935 Fax: (015) 268 2306, Email: anastasia.ngobe@ul.ac.za

TURFLOOP RESEARCH ETHICS COMMITTEE

ETHICS CLEARANCE CERTIFICATE

**MEETING:** 24 April 2020

**PROJECT NUMBER:** TREC/64/2020: PG

**PROJECT:**

| | |
|---|---|
| **Title:** | An Analysis of Hazardous Waste Across Different Land Use Zones in Musina Local Municipality, Limpopo Province, South Africa |
| **Researcher:** | HA Nematshavhawe |
| **Supervisor:** | Dr MR Ramudzuli |
| **Co-Supervisor/s:** | Prof MJ Potgieter |
| **School:** | Health Care Sciences |
| **Degree:** | Master of Science in Geography and Environmental Studies |

**PROF P MASOKO**
**CHAIRPERSON: TURFLOOP RESEARCH ETHICS COMMITTEE**

The Turfloop Research Ethics Committee (TREC) is registered with the National Health Research Ethics Council, Registration Number **REC-0310111031**

**Note:**

i) This Ethics Clearance Certificate will be valid for one (1) year, as from theabovementioned date. Application for annual renewal (or annual review) need to be received by TREC one month before lapse of this period.

ii) Should any departure be contemplated from the research procedure as approved, the researcher(s) must resubmit the protocol to the committee, together with the Application for Amendment form.

iii) PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES.